THE GEM-CUTTER'S CRAFT

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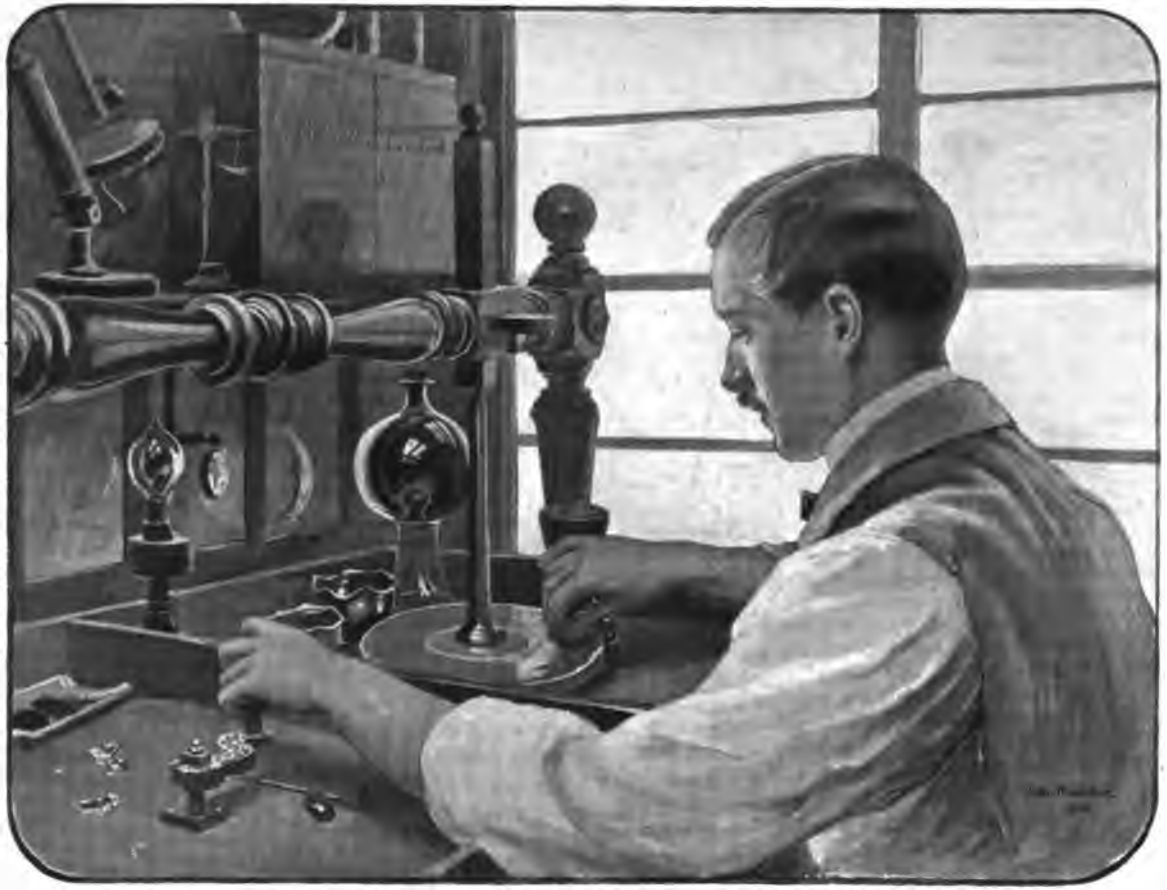

SKETCH OF THE AUTHOR AT WORK. BY JOHN W. HARRISON.

THE GEM-CUTTER'S CRAFT

BY

LEOPOLD CLAREMONT

AUTHOR OF "A TABULAR ARRANGEMENT OF THE DISTINGUISHING CHARACTERISTICS AND LOCALITIES OF PRECIOUS STONES" IN THE "MINING JOURNAL"

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PREFACE

THERE are many books upon the subject of precious stones, but I think the present one is the first to be written by a practical gem-cutter. I have frequently been asked, What do certain gems look like before they are cut? How can one tell one kind of precious stone from another? What gems are likely to be found associated with such and such minerals?

In the following pages I have tried by means of a few short descriptions and photographs to convey a general impression of the appearance, etc., of the different kinds of gem-stones, together with an outline of the industry and craft of gem-cutting, avoiding at all times any tiresome technicalities.

I do not address myself especially to the jeweller, the miner, the collector, the dealer, the lapidary, or the amateur, but that my book may prove of interest and assistance to some of these I sincerely trust.

It is impossible in a book of this kind to do more than hint at the many sciences, such as crystallography, optics, mineralogy, etc., which bear upon the subject of precious stones, a knowledge of which is necessary for the serious study of gems.

My best thanks are due to:

Mr. Consul-General Hertslet, for details of the "sawing of diamonds," etc.

Mr. Cecil H. Cribb, B.Sc. (Lond.), F.I.C., public analyst, for assistance in connection with chemistry.

Mr. John W. Harrison, for his clever sketch which forms the frontispiece of my book.

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Mr. John Plummer of Sydney, for the particulars of opal mining in Australia.

The authorities of the British Museum, for kindly allowing my photographer, the late Mr. T. C. Hepworth, access to the collection of minerals.

The Secretary, The Burma Ruby Mines, Ltd., for the use of photographs of the mines.

Messrs. Wilson and Co., for the use of photographs of the South African Diamond Mines.

The proprietors of the "Pall Mall Magazine," for permission to reproduce some of the illustrations from the interview with me in their publication.

Messrs. Cassell and Co., Ltd., for permission to reproduce the illustrations from the article "From the Mine to the Ring," from Cassell's Magazine.

The proprietors of "The Sphere," for the illustration of the large Premier Diamond.

The proprietors of "The Mining Journal," London, for allowing me to reproduce some of my articles which have appeared from time to time in their journal.

LEOPOLD CLAREMONT.

38, CONDUIT STREET, W.
October, 1906.

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Precious stones are rare minerals which (to the exclusion of metals) possess sufficient beauty to warrant their use as personal ornaments, and sufficient hardness to render them suitable for the purpose.

THE GEM-CUTTER'S CRAFT

CHAPTER I

THE IDENTIFICATION OF PRECIOUS STONES

FOR the successful identification of precious stones nothing is of greater value than the experience which is only attainable by constantly handling large quantities of rough and cut gems.

In this way the faculties become educated to differentiate between the most minute details to such an extent that it becomes possible, not only to identify nearly any known variety of gem stone almost at a glance, but even from a large parcel of cut stones to separate a few which have been obtained from a different mine to the others.

Invaluable as this experience undoubtedly is, it is but the outcome of close scrutiny and mental judgement resulting in the expression of an opinion, which is of greater or less value according to the experience gained. Therefore in order that absolute certainty as to the identity of a given stone may be attained, it is necessary that certain tests made possible by the science of mineralogy shall be applied to the doubtful gem.

The results of these scientific tests constitute "proof positive," and it is advisable that they be

used to justify one's opinion, even if such be arrived at after many years spent in actual contact with precious stones.

In addition to the fact that many gems resemble others to a greater or less degree in appearance, it often happens that a gem will present some unusual effect of colour or diaphaneity, calculated to mislead the unwary.

Often, too, it is necessary to identify some minute fragment of a stone which does not possess the characteristic appearance of any particular gem, but upon which the future of a new mine may possibly depend. **Crystallography.** A knowledge of crystallography, or the science of natural crystals, is essential in connection with the study of precious stones in the natural state, for though it frequently happens that gems are found exhibiting little more than a few traces of the geometric formation with which most of them are by nature endowed, yet it is of the greatest importance that such be carefully studied with a view to connecting them with the six different systems into which all crystals are classified.

Precious stones from the very moment of their formation are subject to all kinds of vicissitudes, such as being crushed and knocked about in the beds of rivers and mountain torrents, and also to chemical alteration. Thus they are often placed upon the market in the form of water-worn pebbles or broken fragments.

It is impossible to do more than make the barest reference to the subject of crystallography in the present little work, for it is one which, treated most modestly, would occupy the entire volume. The following are, however, the names of the six systems

into which the natural crystals are classed : (1) The cubic or monometric; (2) the pyramidal, dimetric or tetragonal; (3) the hexagonal or rhombohedral; (4) the prismatic, trimetric, or orthorhombic; (5) the oblique or monoclinic; (6) the triclinic or anorthic.

Fracture. While studying a rough precious stone with this object, careful attention should be directed to the nature of any fractured surfaces, which may either appear splintery, hackly, conchoidal, sub-conchoidal, uneven or even, also the presence of any indication of cleavage, which, if it exists, may either be perfect or imperfect in various directions according to the variety of the stone under examination. **Cleavage.**

Striae. The direction and nature of any striae should also be noted. **Diaphaneity.** The diaphaneity, or degree with which a gem transmits light is of importance, and is divided into the following degrees :

Opaque, semi-opaque, sub-translucent, translucent, sub-transparent, transparent.

Lustre. The surface lustre of a gem is also noteworthy; it may be either adamantine (resembling that of the diamond), resinous, vitreous, pearly or waxy.

Colour. The colour of a gem stone, although of the greatest importance with regard to its value upon the market as a jewel, is of little or no account as a guide to its identity, as not only are there several gems which occur in nearly all the different colours, but it occasionally happens that a gem is found possessing the colour which is considered almost characteristic of a different variety of stone.

As an instance of this may be mentioned the chrysoberyl, which generally occurs in shades of yellow, sage green, and autumn brown, yet there is a some-

what rare variety of this gem which closely resembles in colour the delicate sea-green of many aquamarines, from which it is impossible to distinguish it by the colour alone.

Shades of Colour.

It is, however, the case that certain *shades of colour* are peculiar to different gem stones, but it is most unwise to accept them as evidence of identity.

It is therefore advisable in the identification of

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THE VALUE OF COLOUR.

Yellow diamond, weight 100 carats, value £4,000.

Blue-white diamond (partly polished), weight 50 carats, value £10,000.

gem stones to try to ignore the quality of colour until after the application of several tests, when, if it tends to confirmation of the results obtained, the colour may be considered as valuable evidence and not before.

Every kind of precious stone is most highly valued by connoisseurs when occurring in its most rarely seen colour, therefore this is called the "perfection colour" of a gem. The perfection colour of ruby is known as "Pigeon blood," of the sapphire "Cornflower" or "Royal" blue. The finest emeralds are

called rich "velvety" green. Diamonds should be "blue white." An alexandrite of perfect quality is "pistachio green" by day, and "raspberry red" by artificial light.

It is indeed seldom that stones of perfection quality are seen upon the gem market, but those gems which most closely resemble the desired colour are proportionately sought after, and command the highest prices.

To such a very great extent do different specimens of the same kind of gem vary in colour that the slightest difference of shade often means the distinction between a stone of great value and one of common quality. Yet when one is guided solely by one's sense of beauty, setting aside conventional laws ruling such matters, it must be admitted that the gems of rare colour are not always the most beautiful.

Hardness.

The property of precious stones of withstanding attrition constitutes what is known as hardness, and as many different kinds of gems vary in hardness one from another, this constitutes a valuable means of distinguishing them. It must, however, be remembered that many of the hardest gem stones are also very brittle, and it is no uncommon occurrence for a gem of any degree of hardness to be seriously damaged by a slight blow, or even by the careless application of the test of hardness.

The mineralogist Mohs, many years ago, drew up a scale of hardness represented by ten transparent minerals, and this arrangement is universally accepted as the standard of hardness by all mineralogists. The following is Mohs' scale of hardness:

Diamond . . .	10	Apatite	5
Sapphire . . .	9	Fluorspar . . .	4
Topaz	8	Calcite	3
Rock Crystal . .	7	Rock Salt . . .	2
Felspar . . .	6	Talc	1

The method of applying the test of hardness to a

CASE OF STONES FOR TESTING HARDNESS.

doubtful gem stone is to endeavour to scratch it in turn with each of the minerals in this scale until one is found that will neither scratch it nor be scratched

by it. It may then be assumed that the gem is of the same hardness as the test stone.

Although this process seems very simple, considerable skill and delicacy of touch are necessary to appreciate the degree of hardness to a nicety, and to avoid damage to the stone under examination. The test stones can be pointed and mounted in small metal holders, so as to be more easily manipulated.

It is sufficient for ordinary purposes to use the four hardest members of the scale, and when they are mounted in the way I have described they can be conveniently carried in a small leather case. The tools and instruments used for cutting and polishing precious stones enable expert lapidaries to test the hardness of a gem without resource to the system of scratching with test stones. The following is a list of some of the principal gem stones, showing their position in Mohs' scale of hardness:

Diamond	10	Almandine Garnet	7.3
Sapphire	9.0	Essonite	7.0
Ruby	8.5	Amethyst	7.0
Chrysoberyl	8.5	Kunzite	6.5
Spinel	8.0	Peridot	6.4
Beryl	8.0	Adularia	6.3
Topaz	8.0	Green Garnet	6.0
Jargoon	7.5 to 8	Opal	6.0
Emerald	7.5	Turquoise	6.0
Tourmaline	7.5	Sphene	5.0
Phenakite	7.5		

The test of hardness should not be applied to the edges or angles of rough crystals, as not only are these slightly harder than the crystal faces, but the result might be damaging to the gem stone. Also

it is not advisable to scratch a polished gem anywhere except upon the edge or girdle of the stone, as considerable difficulty might be experienced afterwards in removing the scratches, to say nothing of loss of valuable material.

Specific gravity.

The specific gravity or relative weight, compared with an equal bulk of water, of precious stones, is of the greatest importance in discriminating gem stones. There are several methods of ascertaining the specific gravity of gems by means of balances of ordinary or of special construction, but they take too long and are unsuitable for everyday work, especially in the case of small stones.

A very convenient and simple method of ascertaining the specific gravity of gems is by immersing them successively in a series of liquids of gradually increasing and *known* density, until one is reached in which the stone just floats. The specific gravity of the stone is then obviously somewhere between that of the last liquid and of the solution preceding it, in which it just sinks, and the accuracy of the method depends upon the number of liquids at the disposal of the operator and the smallness of the gradations in density between them.

For all but stones of the highest density, three different solutions are available.

Dr. Max Bauer's recommendation.

Methylene iodide is recommended by Professor Bauer. At ordinary temperature the specific gravity of this liquid is 3.32 which can be reduced to any lower density by the addition of benzene, or preferably toluene, and raised to 3.6 by saturating with iodine and iodoform. This liquid has the disadvantage of being dark in colour, so that stones sinking in it cannot be seen, and in addition to this, has a

disagreeable smell which clings tenaciously to the hands and clothes.

A second liquid, which does not suffer from these defects, is an aqueous solution of cadmium borotungstate, recommended by Professor Church. This can be prepared so dense that it has a gravity of

CABINET OF SPECIFIC GRAVITY SOLUTIONS.

3.28, and can, of course, be diluted with water to any required extent.

Prof. Church's suggestions.

The third liquid suitable for the purpose is that known as Sonstadt's solution, of which I have now had many years' experience, with entirely satisfactory results. Acting on Professor Church's suggestions, I keep it made up in the following strengths: Solution A, S. Gr. = 3.17; Solution B, S. Gr. = 2.9; Solution C, S. Gr. = 2.67; Solution D, S. Gr. = 2.63. These solutions are of a bright yellow

colour, and the only disadvantage attached to them is that they are exceedingly poisonous and rapidly corrode most metals, other than iron, with which they may be brought into contact. Steel forceps being unaffected by them may be used for inserting and removing the gems. (See Appendix.)

It will be found that neither methylene iodide, cadmium borotungstate, nor Sonstadt's solution are sufficiently dense to float some of the heaviest stones. This failing was remedied a few years ago by the discovery by the Dutch mineralogist Retgers, of a colourless compound which melts at a fairly low temperature to a clear liquid five times as dense as water, and therefore heavy enough to float all the different varieties of precious gems. This compound is the double nitrate of silver and thallium, and possesses the property of mixing in any desired proportion with warm water, the specific gravity being regulated by dilution with little trouble. (See Appendix.)

Dutch mineralogist, Retgers.

Turquoise should not be immersed in any of these liquids, as it might possibly alter in colour.

The following is a list of some of the principal gem stones, with their respective specific gravities:

Jargoon . .	4.7	Chrysolite .	3.3 to 3.5
Garnet . .	4.2	Peridot . .	3.3 to 3.5
Ruby . . .	3.9 to 4.2	Kunzite . .	3.2
Asteria . .	3.9 to 4.2	Tourmaline .	2.9 to 3.3
Sapphire . .	3.9 to 4.2	Phenakite .	2.9
Diamond . .	3.52	Turquoise .	2.6 to 2.8
Chrysoberyl .	3.5 to 3.8	Emerald . .	2.6 to 2.7
Alexandrite .	3.5 to 3.8	Amethyst . .	2.5 to 2.8
Cat's-eye . .	3.5 to 3.8	Moonstone .	2.39
Spinel . . .	3.5 to 3.6	Opal . . .	2.21
Topaz . . .	3.4 to 3.6		

Action of Light.

The action of light upon transparent gem stones

gives rise to the following effects which are all intimately connected one with another:

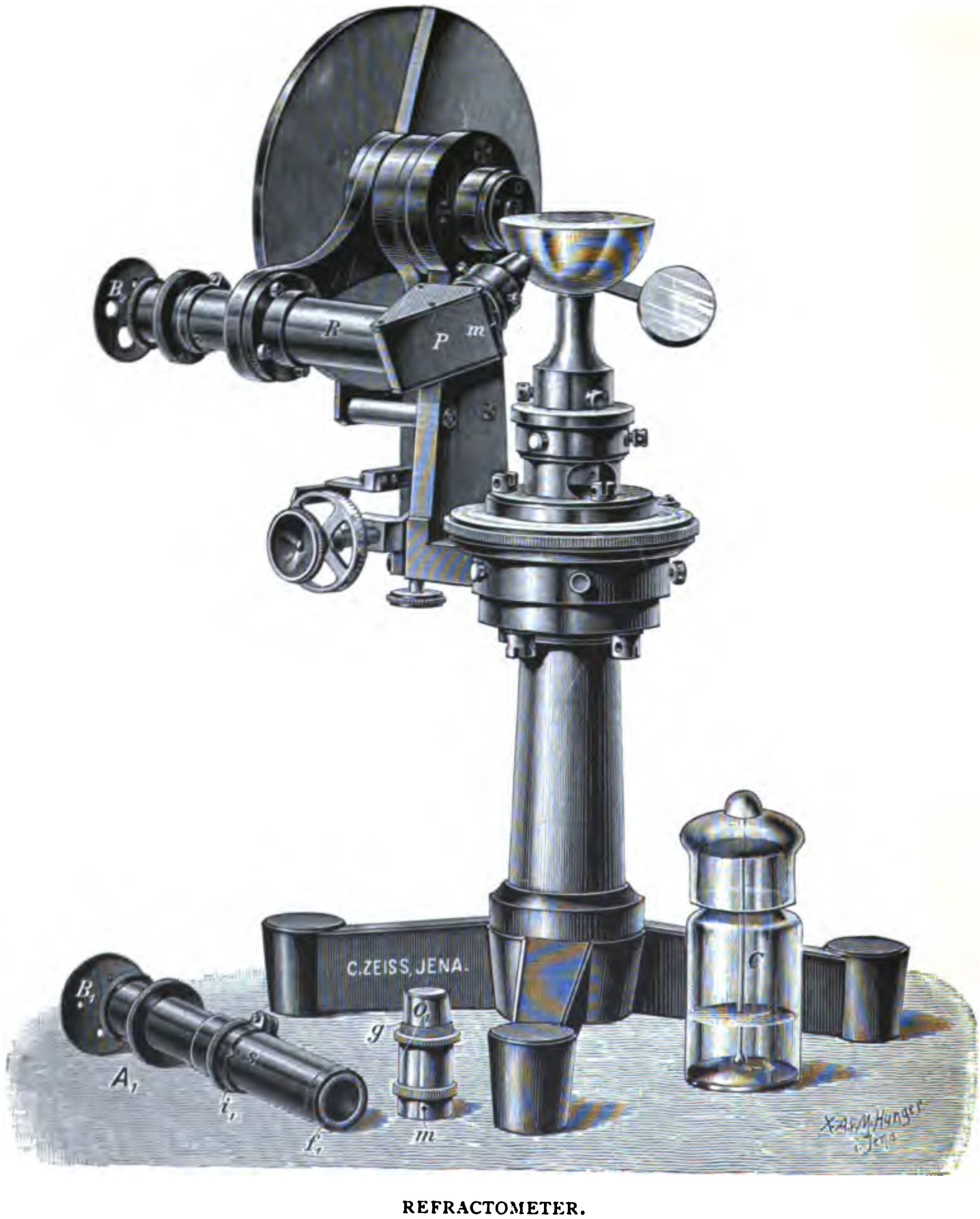
Refraction (single and double)
Dispersion
Polarization
Pleiochroism

and to these the fire, lustre, and other attractive qualities of precious stones are entirely due.

These optical properties of precious stones furnish valuable means of distinguishing them one from another, and there are various fairly practical scientific tests which may be used for this purpose. Professor H. A. Miers, F.R.S., has fully described these tests in his most interesting lectures delivered at the Imperial Institute, Society of Arts, University College, etc., and some of the following paragraphs are from my notes taken on these occasions.

The tests to which I refer depend almost entirely upon the refraction, single and double, and the absorption of light during its passage through the gems; it is almost impossible to apply some of these tests to a rough gem on account of the scratched and broken surface of the crystal, but they will be found very useful as an aid to the discrimination of cut and polished specimens.

A characteristic property of a transparent precious stone is the extent to which a ray of light is refracted upon entering and leaving the gem. It would be absurd to contemplate cutting the gem into a prism and measuring the refraction of light in the usual way, therefore the mode of procedure is to select two of the facets which form a suitable angle, and then to carefully paint over the remainder of the gem;



REFRACTOMETER.

the ray of light may then be traced through these two facets, and by means of the goniometer, not only the refraction, but the double refraction may be measured, no matter how great may be the refractive power of the gem stone. For this purpose an instrument called the refractometer may also be used, but only, unfortunately, for gems whose power of refraction is not great.

Refractometer.

The refractometer consists of an eyepiece containing a graduated scale, through which is viewed a hemispherical glass lens. All that is necessary is to loosely place the gem, which has previously been moistened by a drop of some liquid possessing a higher power of refraction than itself, such as monobromonapthalene, upon the plane surface of the hemisphere. Upon looking through the eyepiece of the instrument a shadow may then be observed over half the field of view, its edge crossing the scale at a point showing the exact refractive index of the gem. The illustration given is of the "Abbe Crystal Refractometer," made by Carl Zeiss of London and Jena.

The following results of the measurements of the indices (for the yellow ray) of a few transparent gems will be of interest:

Diamond . . .	2.45	Phenakite . . .	1.673
Jargoon . . .	1.96	Topaz	1.619
Ruby	1.777	Aquamarine . .	1.595
Sapphire . . .	1.742	Rock Crystal . .	1.547

Pleiochroism is the property possessed by coloured doubly refractive gems of appearing of distinctly different colour or shades of colour when viewed through different directions of the crystal.

This effect can generally be appreciated by the naked eye, but can always be detected by means of the dichroiscope. This little instrument consists of a metal cylinder containing a cleavage rhombohedron of Iceland Spar, and possesses an eyepiece containing a lens at one end, and a small square aperture at the other. The eyepiece is held to the eye, and the gem to be examined is placed between the other end of the cylinder and the light. Two images of the square opening at the other end of the dichroiscope may then be seen, and they will appear either of different colours or of absolutely the same colour, according to the nature of the gem stone under examination.

Dichroiscope.

DICHROISCOPE.

If it be found that two images, exactly the same in colour, of the square aperture can be seen, no matter in which direction the gem be viewed, it is singly refractive, for all the doubly refractive gems show the two images of the square opening of the instrument of distinctly different colours when viewed at any angle, except that parallel to the principal axis of the crystal.

The dichroiscope furnishes a most convenient and easy means of distinguishing those gems which crystallize in the cubic system from those belonging to the five other systems of crystallization. This test can be applied quickly to any doubtful specimen, whether in the rough or cut state, with equally satisfactory results. The following table shows some

of the principal gem stones, the natural colour of each gem, and the twin colours into which each is resolved under examination with this instrument:

Name of gem.	Colour of gem.	Twin colours seen with Dichroiscope.
Ruby . . .	Red . .	Crimson and Carmine.
Sapphire . .	Blue . .	Dull Green and Blue.
Tourmaline .	Green .	Chartreuse Green and Bluish Green.
Tourmaline .	Red . .	Lilac and Rose Pink.
Tourmaline .	Blue .	Dark Gray and Blue.
Emerald . .	Green .	Yellowish Green and Bluish Green.
Aquamarine .	Green .	Straw and Grayish Blue.
Peridot . .	Green .	Yellowish Brown and Sea-Green.
Topaz . . .	Yellow .	Sherry Yellow and Pink.
Chrysoberyl .	Yellow .	Golden Yellow and Greenish Brown.
Iolite . . .	Violet .	Drab and Blue.

Polarizing Microscope.

The effects observable upon looking through a doubly refractive gem by means of the polarizing microscope are very characteristic, and may be used as an aid to the distinguishing of different stones with great advantage.

These effects are generally known as "interference figures," and it is necessary to look through the stone in the direction parallel to the principal axis of the crystal. In the case of a cut and polished gem this direction may lie disposed from some projecting angle to another within the stone, and consequently it can be examined only with considerable difficulty, owing to the refraction of the stone; therefore, the best mode of procedure is to immerse the gem in some liquid, such as oil or glycerine, which has nearly the same refractive power as itself. If a spherical glass vessel containing the liquid be used, it can then be turned about until the stone within is found to be in the desired position for successful examination, and the interference figure can thus be seen.

SPECTROSCOPE.

Spectro-scope.

There are two gems, namely, jargoon and almandine garnet or carbuncle, which give characteristic black bands across the spectrum when examined by means of the spectroscope. Even a pocket instrument answers the purpose fairly well, and although in some specimens of these stones it is difficult to see the desired effect through the instrument, it is attained with the utmost ease in others, in which case all doubt as to the true identity of the gem stone may be dismissed. The presence of these black bands in the spectrum was discovered by Professor A. H. Church, F.R.S. Many gems become electrified by heat, friction or pressure; this phenomenon is most apparent in tourmaline. If a crystal of tourmaline be warmed, it rapidly becomes electrified, one end becoming positive and the other end negative. Professor Kunz has devised a clever little experiment in connection with this property which is sometimes useful as a test for the stone. If a mixture of finely powdered red lead and sulphur be passed through a sieve upon a tourmaline which is being carefully warmed, the particles become electrified by mutual

Electricity.

friction, and the positively electrified end of the tourmaline attracts the negatively electrified yellow sulphur, and the negatively electrified end of the stone attracts the positively electrified red lead, causing one end of the stone to appear red and the other end yellow. There is no reason why this test should not be equally successful both in cut and uncut specimens.

For the successful diagnosis of precious stones it is well to carefully balance the results of several tests in one's mind, as one test is rarely conclusive.

Under the heading of this chapter I have chiefly written of the tests and characteristics of those gems occurring in nature in the form of crystals, but there are several gem stones, such as turquoise, opal and chrysoprase, which are calloid or cryptocrystalline, that is, they occur more or less in a massive form, and are also singly refractive when transparent.

CHAPTER II

GEMS UNDER THE X-RAYS

IN January, 1896, the news came from Vienna that Professor Röntgen, of Würzburg University, had made a startling discovery, and a week later the English papers were full of the wonders achieved by what was called "The New Photography." The term was a misleading one, for it was soon seen that the discovery was of an electrical kind, and that photography had nothing to do with it beyond acting as a recorder of the phenomena obtained.

Crookes' Tube.

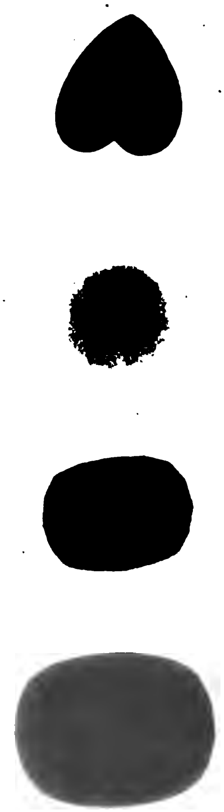
Professor Röntgen had discovered, while experimenting with what is known as a Crookes' tube (a vessel of glass exhausted to about one-millionth of an atmosphere through which a current of electricity from an induction coil is made to pass, with which Professor Crookes conducted his classical experiments on radiant matter), that this tube gave out invisible radiations which would affect a photographic dry plate in the same manner that such a plate is affected by light. These same radiations, which, in consequence of their unknown nature, the Professor christened X-rays, were found to easily penetrate certain substances which are opaque to light, while they would be stopped by some of the things which are quite transparent to light. Thus all forms of carbon are transparent to these mysterious radia-

tions, including coal, coke, lignite, and graphite, whilst rock crystal, glass, iceland spar, etc., are quite opaque. The method of putting these matters to actual test is a simple one; a gelatine dry plate, such as one can purchase of any dealer in photographic materials, is wrapped in two or three thicknesses of black paper, thus being protected from access of light which would, of course, spoil it. It is then placed flat on a table a few inches beneath the Crookes' tube, which has already been connected with an induction coil. On the top of the enveloped plate are placed the substances to be tested, and it will be found, after a few minutes' exposure to the radiations from the tube, upon development of the photographic plate, that those things which are impervious to the rays have cast heavy black shadows, while those which are transparent have left but faint evidence of their presence.

If the human hand be placed above the plate, it is found, on development, that the flesh is semi-transparent, while the bones are comparatively opaque. This circumstance has proved of great importance in surgery, for it is possible by using the X-rays to examine and ascertain the condition of a fractured or diseased bone. The fact, too, that the metals are opaque to these radiations, has proved of remarkable importance to the surgeon, for bullets, needles, and other foreign bodies in the flesh can be readily located. X-ray apparatus is now invariably carried by field hospitals in time of war, and hundreds of lives have been saved by the revelations thus afforded as to the exact position of hidden bullets.

It has already been stated that all forms of carbon

are transparent to the X-rays, and the reader will, therefore, be prepared for the statement that diamonds cast no shadows. If more ready tests did not exist, the X-rays would show, in a very conclusive manner, an important physical difference between that beautiful gem and the many inferior stones which are sometimes made to pass muster for it.



RADIOGRAPH OF FOUR GEMS: OPAL, BRILLIANT, BERYL, SAPPHIRE.

Radiographs.

In the accompanying radiographs are shown the shadows cast by four precious stones when these gems were submitted to examination by the X-rays in the manner already detailed. At the top is a heart-shaped opal, the opacity of which is well marked; No. 2 is a brilliant, showing the greater thickness towards the centre; No. 3 is a beryl, and No. 4 a large sapphire, both of which, it will be noted, give black shadows as proof of their opacity to the Röntgen rays.

To make the matter still clearer, two other pictures are here reproduced, one a photograph taken with a camera in the ordinary manner, and the other a radiograph of the same objects. The subject is a human hand, upon which have been placed the

jewels just adverted to, with the addition of a glass stopper for the sake of comparison. The size of the hand, which is that of an adult, serves as a guide to the dimensions of the stones. We can here recognize the heart-shaped opal with the brilliant just

PHOTOGRAPH OF GEMS UPON THE HAND.

above it, while at the root of the fingers is the big sapphire and the smaller beryl. The glass stopper is placed far below, near the thumb.

Now look at the corresponding radiograph, and note how the bones of the fingers can be seen through the transparent diamond, and how their images are obliterated by the dark shadows of the other stones.

The expert in gems has no necessity for appealing to the X-rays for evidence as to the genuineness of the stones with which he deals, for he has methods ready to his hand which, while giving results quite

RADIOGRAPH OF GEMS UPON THE HAND.

as conclusive, are less formidable and expensive. Still, the matter is full of interest, and it is especially noteworthy that the conclusion at which the chemist long ago arrived, that the diamond was merely carbon in a crystallized condition, is fully corroborated by Röntgen's X-rays.

CHAPTER III

THE NOMENCLATURE OF GEMS

THE student in precious stones has many difficulties to overcome before he can successfully identify every kind of gem, both in the rough and cut states.

By no means the least of these difficulties lies in the great confusion which exists with regard to the names of precious stones. Gems seem to have acquired their names quite irrespectively of any system of nomenclature, and with an utter disregard to their relationship one with another, as a difference which makes a distinction between one set of gems makes no distinction at all between another set. **Confusion.**

For instance, a diamond which is crystallized carbon, is always called a diamond, without regard to its colour, and there are red, yellow, green, blue and black diamonds, besides the white stones so familiar to everyone.

Yet the gems composed of crystallized alumina receive a different name for every colour; the red variety is called ruby; the blue, sapphire; the yellow, Oriental topaz; the green, Oriental emerald; the purple, Oriental amethyst; and a whole host of delicate shades of every colour are known as fancy sapphires.

The asteria or star stone is still another variety

of this crystallized corundum which occurs in many different shades of colour, and displays a shimmering, glittering, six-pointed star, diverging from the centre to the edge of the gem, presenting an appearance quite unlike any other precious stone.

The spinel is a beautiful gem which occurs in almost every colour in many different shades, and is known as blue, green, purple or red spinel respectively. The red and blue varieties of spinel are not infrequently called spinel rubies and spinel sapphires from their resemblance to rubies and sapphires.

This sometimes causes confusion, and it is a pity that the name of one stone has in this way become used in conjunction with that of another, but the reason is only too obvious. One gem is of greater value than the other, therefore, to supplement the less expensive gem with the name of the more costly one, necessarily carries weight with those persons who are unfamiliar with precious stones.

Faulty Nomenclature.

In fact, this kind of thing is the explanation of most of the difficulty of the faulty nomenclature of precious stones. In several cases two or more absolutely distinct and separate gems have been allowed to masquerade under one title, those of less value reaping the benefit of the prestige of the more costly.

An example of this is readily to be found in the cat's-eye. The true cat's-eye, a variety of chrysoberyl, is a most valuable gem, varying in colour from rich gooseberry green down to soft honey yellow, and displaying a glittering streak or ray resembling the iris of a cat. There are also two varieties of quartz known as cat's-eyes, which present a some-

what similar appearance, but lack the great lustre and brilliancy of the chrysoberyl cat's-eye; these quartz cat's-eyes are almost valueless, yet they are cut, mounted, and sold at a low price to purchasers who are often unaware that such a thing as a chrysoberyl cat's-eye exists.

Topaz occurs pink, blue, white, and yellow, but always bears the same name with a prefix descriptive of the colour. This is another gem which labours under the disadvantage of having an ugly sister known as Scotch topaz, which is only yellow crystal and does not possess the beauty and lustre of the true topaz; nor must it be confused with the beautiful Oriental topaz or yellow sapphire already referred to.

There is a family of precious gems known as the beryl group, of which the chief is the costly and popular stone, the emerald, differing only in colour from the aquamarine—pale green or blue—and from the sage-green variety, termed beryl.

The beryl must not be confused with the chrysoberyl, which is an effective but by no means rare stone, unless in the form of cat's-eye, occurring in shades of rich green and yellow. The only other kind of chrysoberyl of great value is the alexandrite.

Fine alexandrites possess the property of changing colour; by daylight they are bright green, and by artificial light they are bright red. Good specimens of these stones are extremely rare, and inferior ones do not change colour in such a marked way.

Jargoons or zircons are inexpensive gems, and, scientifically, rank next in brilliancy to diamonds.

They are found in many colours, but are always called by the same name except when they are honey-coloured, when they go under the name of jacinth.

The name of jacinth is also sometimes given to a honey-coloured garnet; in fact, most of the jacinths sold are this variety of garnet. This has become so universal that it may be considered that the name jacinth includes the jargoon and garnet of honey colour; the correct name of this kind of garnet is essonite or cinnamon stone, and is known as such to mineralogists.

This is not the most valuable kind of garnet, for there is a green variety, generally misnamed olivine, which is extensively used in high-class jewellery; its colour is a vivid verdigris green, with a high lustre. The ordinary red garnet, though a beautiful and effective stone, is found in such large quantities that it has little or no commercial value.

The peridot, which is the true olivine and thus known to the mineralogists, is a leaf-green gem of great beauty, found in large quantities on an island in the Red Sea, and much used in high-class jewellery.

The same stone sometimes occurs a delicate primrose yellow, when it receives the name of chrysolite. The chrysolite is not so valuable as the peridot, though really fine specimens of it are equally rare.

The turquoise is a sky-blue opaque stone, the finest specimens being found principally in Persia and the Sinai Peninsula, though America and Australia produce a variety of inferior hardness and texture.

There is also a substance known as fossil turquoise, which somewhat resembles the real stone

this consists of the fossil remains of ivory and bone which have become coloured naturally in the course of ages by phosphate of copper. The fossil turquoises always show, on careful examination, the bony structure of the substance of which they are composed, and do not retain their colour or polish like the real turquoises.

Tourmalines are very effective, and though unappreciated in Europe, find ready purchasers in America and among the potentates of the East. There are red, blue, yellow, green, and brown tourmalines, the first two being respectively known as rubelite and indicolite—the latter very rare.

Derivations.

The Hebrew name for diamond is Jahalom, which is derived from *halam* (to smite), in allusion to its extreme hardness and its abrasive power upon all other stones.

The name of the ruby is merely expressive of its red colour, by which it was distinguished from the other varieties of the hyacinthus.

The word sapphire was used by the ancients in connection with a blue stone called lapis-lazuli, and was merely an epithet expressive of its azure colour; but in course of time it became associated with the blue variety of corundum, which forms the stone known as sapphire to-day.

The word jacinth comes to us from the Italian *giacinto*, which can be traced to the Latin *hyacinthus*. The cat's-eye was named from the resemblance of the gem to the iris of a cat. The modern emerald is undoubtedly the variety of gem known to the ancients as *smaragdus*, the Greek equivalent of the Persian *samarrud*. The word turquoise indicates that this gem was first procured from the Turks.

The name asteria was applied by Pliny to the asteriated crystals of corundum, and is also known as the star-stone.

Topaz is derived from the Greek *topazios*, an island in the Red Sea whence the ancients obtained a yellow stone which was, however, probably the gem known to-day as chrysolite. The word tourmaline is derived from the Cingalese *turmali*. Garnet comes from the Latin *granatus* (grain-like), and peridot from the Arabic *feridet* (precious stone).

Chrysolite comes from the Greek *chrusous* (golden) and *lithos* (a gem), while beryl comes from the Low Latin *beryllus*, and aquamarine from the Latin *aqua* (water) and *marina* (appertaining to the sea). Phenakite is traced to a Greek word meaning "a deceiver," in allusion to its resemblance to quartz, for which it has often been mistaken, and euclase to the Greek words signifying "to break easily," which indicates that the stone is easily fractured. Zircon comes from the Arabic *zerk* (precious stone); chrysoberyl, from the Greek *chrusous* (golden) and *beryllus* (beryl); spodumene, from the Greek *spodios* (ash coloured); amethyst, from *a* (not) and *methuo* (to be drunk); and iolite, from the Greek *ion* (violet) and *lithos* (stone); epidote springs from the Greek *epidosis* (increase), with axinite from the Greek *axine* (an axe), and spinel from the Greek, meaning "a little spark." Sphene is derived from the Greek *sphēn* (a wedge), and opal from the Latin *opalus* or the Greek *ophthalmius*, meaning eye-stone.

The alexandrite was named after Alexander I, Emperor of Russia, upon whose birthday it was first discovered.

Corundum comes from the Indian *korund*. Quartz

probably comes from a German word signifying the grating sound made by clay in kneading it.

"Oriental."

The word "Oriental" originally referred to stones coming from the East, but has gradually been applied to almost any stone of value, and great confusion is caused by its indiscriminate use.

Although many of the names applied to the precious stones by the ancients are still in use at the present day, they have been diverted to altogether different gems in several instances; for example, the sapphire referred to in Holy Scripture is the stone known to-day as lapis-lazuli, while the jacinth of the Bible is the modern sapphire.

CHAPTER IV

THE CUTTING AND POLISHING OF PRECIOUS STONES

RECENT researches of the "Egypt Exploration Fund" are of peculiar interest to all students of precious stones, for they brought to light far older examples of jewellery than any known before, and specimens of goldsmiths' craft which are many hundred years earlier than anything of the kind previously found.

Ancient jewels.

The most important objects are the four bracelets found on the mummy of the queen of Zer at El Mehesna. The first consists of a row of façades with the royal hawk alternately of gold and turquoise. The turquoise pieces were made first, and worn with large beads, probably of amethyst, as shown by the wear on the edges; the style of the hawks is like that of Mena, and probably belongs to the beginning of the reign of Zer.

The gold hawks are of the later and more advanced style, which was developed during the reign of Zer; originally there were eighteen pieces of each material, but four of turquoise and five of gold were lost during the wearer's lifetime. Similar ornaments of lapis-lazuli and ivory were found.

The second bracelet has a gold centre piece copied from the centre of a lotus flower; on each side is a group of turquoises and a large amethyst

ball, and the side parts are of plaited gold and hair.

The third bracelet is of spiral beads of dark lapis-lazuli and gold, with small beads of turquoise.

The fourth bracelet is of hour-glass shaped beads of gold and amethyst. Each of these designs is quite independent of the others, and each kind of bead was made individually for its intended place. The soldering of the gold is technically perfect, showing no trace of excess or of difference of colour.

The arm on which these bracelets were found had been at some remote period torn from the rest of the mummy by plunderers of the tomb and hidden in a hole in the wall. There it was overlooked by the builders of the Osiris shrine, by the Coptic destroyers, and by the Arabs of the French Mission. The owner of these jewels lived in the early part of the first dynasty, which extended from 4777 to 4515 B.C. Thus even at this distant period—so remote that one's brain fails to grasp it—precious stones were fashioned, though in a crude manner, and worn mounted as jewels and charms. Further particulars of the jewels I have mentioned may be seen in the report of the above-mentioned Society for the year 1900. The bracelets are exhibited in the museum at Cairo.

There is no doubt that by the ancient races, precious stones were generally used in their natural or uncut state, and were valued more particularly as amulets and antidotes against the evil eye, witchcraft and magic, and in many instances for the healing qualities they were supposed to possess. Subsequent to this period they were roughly wrought into some kind of shape and polished in order to

Uncut State.

ncrease their beauty, and were used for the decoration of goblets, armour, thrones, etc., as well as for personal adornment.

The natural crystallographic faces of most precious stones were evidently made use of by the ancient lapidaries who merely polished the stone in the form in which it was found, or by the addition of a few extra faces made the stone somewhat more attractive in appearance. No doubt the hardness of many gems was a stumbling-block in the way of the primitive lapidaries, for we find as late as the middle ages that rough stones, and diamonds in particular, were mounted as important jewels. In this way, undoubtedly, the cutting and polishing of precious gems came about, but from specimens of stones thus crudely cut, it is quite evident that the sole object of the ancient lapidaries was to retain the original size of the gems upon which they operated as nearly as possible, for we find that, without regard to shape, or flaws, or other faults, they were merely covered with polished surfaces, with no thought of brilliancy or symmetry. As far back as it is possible to obtain any records, diamonds, and many other precious stones were cut and polished in this crude way in India, where, to this day, in the regalias of native princes may be seen gems of untold value, the beauty of which is entirely marred by the want of scientific cutting. For ages past, in India, precious stones have been elaborately carved and engraved, and in many cases, drilled even to the entire length of the stone. Many magnificent gems are seen on the market to-day quite ruined for the purposes of modern jewellery by this wanton sacrifice of valuable material. In order to remove the carving and drill-

Many Gems Ruined.

ing on stones thus mutilated, tremendous loss of weight is necessarily incurred. Some of the old Indian carvings on precious stones are, however, really beautiful in themselves, but though evidently the result of wonderful patience and a large amount of time and thought, the work rarely, if ever, adds to the exquisite beauty of the material. In fact, it would seem as if the stone was looked upon, with true artistic feeling, as a suitable material for displaying the beauty of the carving rather than that the carving should increase the beauty of the gem. This applies also to the cameos and intaglios of the glyptic artists of ancient Greece and Rome, whose exquisite work upon gem stones constitute examples of the inimitable art of the age.

CARVED RUBY, BRITISH MUSEUM (ACTUAL SIZE).

Art of Cutting Gems.

It is difficult to trace the art of cutting precious stones very closely through all ages, as there appear to be few records of the industry obtainable. The earliest date at which gems were cut and polished in Europe seems to be as late as 1285, as a guild of gem cutters existed in Paris at this time. There were also lapidaries known as "table polishers" at work in Nuremburg in 1370, but of what their work consisted or by what means it was executed, we cannot tell.

About 1460, when Bruges was not only one of the principal ports of Europe, but a centre of all branches of art, there lived in this town a craftsman named Ludwig van Berquen, to whom is attributed

the credit of first cutting diamonds with a symmetrical arrangement of facets. Van Berquen discovered that by a certain relationship of the facets on a diamond the reflection and refraction of light were greatly increased. With the exception of various slight modifications this method of polishing diamonds is in use to this day. Many very fine gems undoubtedly passed through Van Berquen's hands, and his name became famous in connection with his work.

Van Berquen.

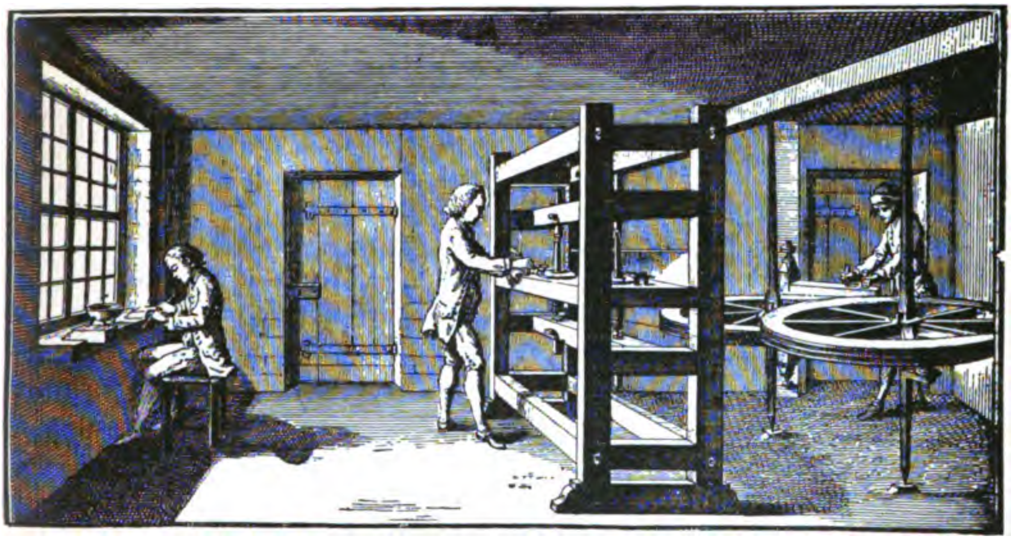
The industry of diamond-cutting thus became established and flourished at Bruges for many years, as we find a guild of diamond cutters there in 1480; but on the death of Van Berquen its members evidently dispersed to other cities, for Amsterdam, Antwerp, and Paris all had their diamond-cutting establishments, those of Paris being the most important. At this period coloured gems were cut almost entirely at Lisbon.

The French retained a great share of the trade, which was patronized by the wealthy and extravagant classes until the social upheaval of the Revolution. In Holland and Belgium, the industry of diamond-cutting became so firmly established that to the present day Antwerp and Amsterdam have almost a monopoly of this work.

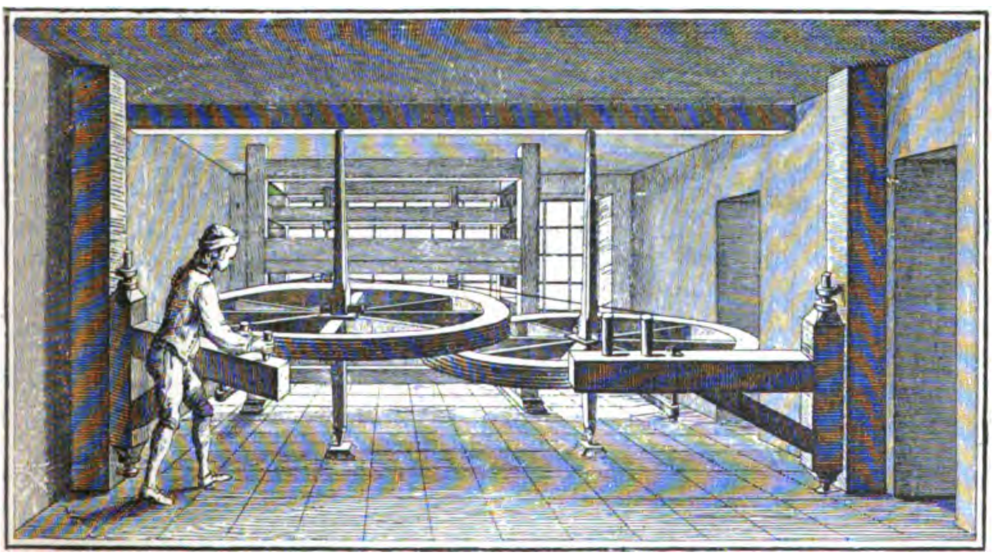
Many fine gems are, however, cut in London, and since the placing of rough stones on the free list of the Dingley law, a share of the business has been attracted to the United States, although the craftsmen employed there are nearly all foreigners.

Diamond Cutters of past generations.

It is difficult to find any records of the tools and instruments used by diamond cutters of past generations, but as our modern methods are of such a very



DIAMOND POLISHING IN OLDEN DAYS (FRONT VIEW).



DIAMOND POLISHING IN OLDEN DAYS (BACK VIEW). FROM AN OLD PRINT.

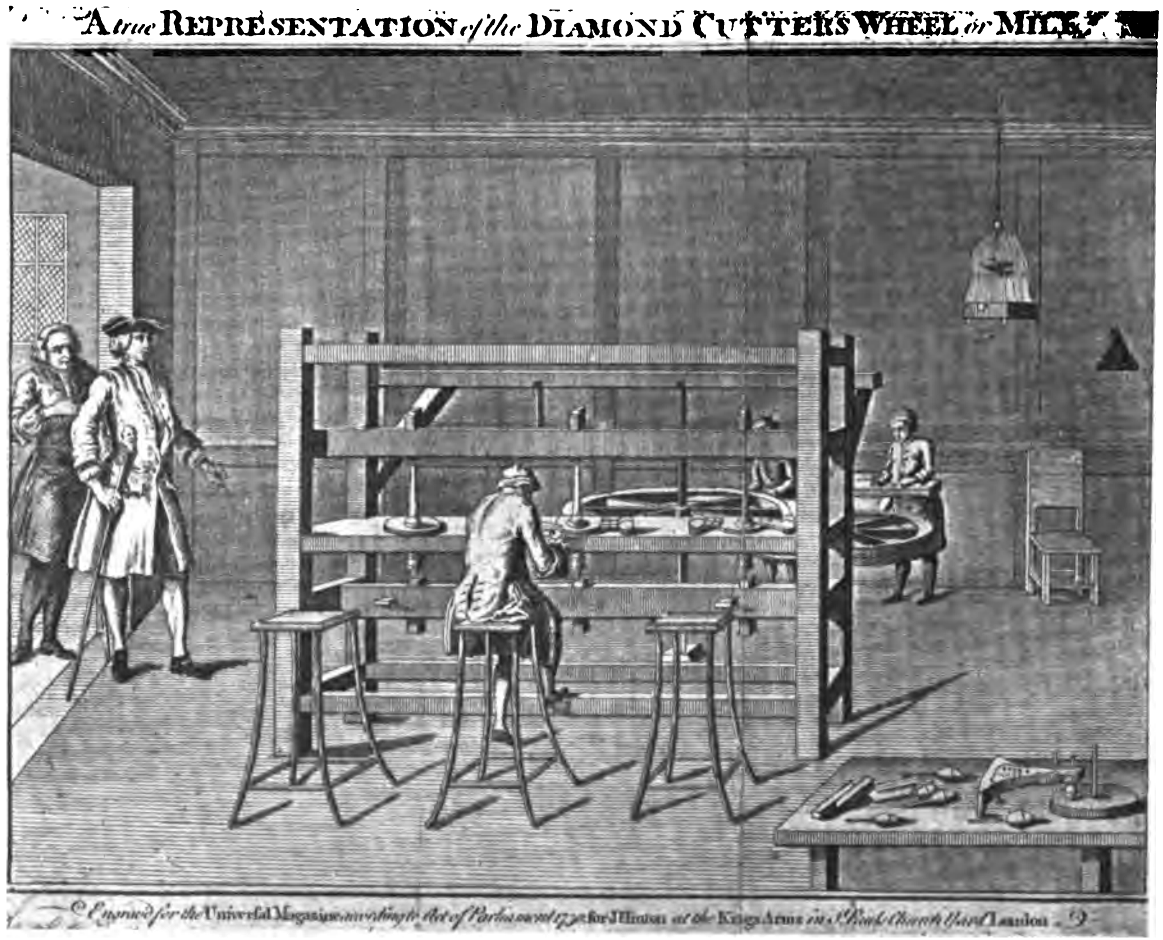
simple nature, it is highly probable that little or no change has taken place in this respect, at all events, during the last century. From some old engravings here reproduced, which, by the costumes of the operators, date back to the end of the eighteenth century, it will be seen that the process of polishing diamonds at that time was very similar to the one now in vogue, except that the mechanical arrangement for turning the wheels has been superseded by the gas-engine and electro-motor.

Lisbon was the home of coloured gem-cutting until the beginning of the seventeenth-century, and the art, almost exclusively practised by Jews, was carried to such a state of perfection that the work of the old Portuguese lapidaries is still famous.

The Jews were, however, at this time expelled from the country and took their arts and crafts to the other cities in which they settled. To London some of them brought the art of gem-cutting, with the result, that not only in that city the finest coloured gems have since been cut, but the greatest gem market of the world became established—Hatton Garden.

Agates. Agates are cut in large quantities at Oberstein, not far from Bingen, where water-power is used to revolve the enormous stone wheels upon which the work is executed. The workmen lie upon their stomachs and press the stones upon the wheel, which is shaped into grooves, by which means large quantities of stones can be cut to the same pattern in a very short time and at small expense.

The industry of agate cutting has flourished to such an extent at Oberstein that no other place in the whole world can compete with it in this class of



DIAMOND CUTTING AND POLISHING IN 1730. FROM AN OLD PRINT.

work. This is chiefly due to the natural facilities of the locality, which contains many rapid streams easily applied to the purpose of turning the wheels. In recent years, lapidary work of almost every other kind has also been introduced into this locality; whole families, from small children upwards, take part in the work, with the result that it is very inferior in quality, but marvellously inexpensive.

I will now endeavour to describe the process of up-to-date gem-cutting, as carried on in a high-class London establishment.

What strikes a casual visitor most forcibly upon entering a modern lapidary's workshop is the *extreme simplicity* and almost primitiveness of the tools and instruments in use. This is the key-note to the art of cutting and polishing precious stones, for the work is essentially a matter of skill and judgment. As it is necessary for the intelligence of the operator to be brought to bear upon every stone, machines for cutting gems have, up to the time of writing (1906), proved of little value, but there are undoubtedly possibilities in this connection.

Beauty depends on Cutting.

In the cutting of rare and valuable gems, the most delicate manipulation is required, as the least particle taken off needlessly, or in the wrong place, the slightest error in judgment, may mean a very considerable diminution in the value of the stone when cut. It is, unfortunately, not well known how much the beauty of a gem depends upon the cutting. Good cutting does not mean the putting on of facets by rule of thumb. To a first-class lapidary every stone is an individual study, and the problem he has to solve is how to produce the maximum brilliancy with the minimum loss of weight in any given speci-

men. The shape of the stone, its quality, diaphaneity, any flaws it may possess, and its depth and tone of colour, etc., have all to be taken into account. The lapidary must keep all these in his mind while determining the shape and proportion of the gem, where a little symmetry, or possibly a little weight, may be sacrificed to brilliancy, or a little brilliancy sacrificed to weight, in order to secure the

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WHAT A DIAMOND LOSES IN CUTTING (ACTUAL SIZE).

Weight in rough state, 250 carats; weight when cut, 115½ carats.

most beautiful and at the same time the most valuable gem that the particular stone in hand is capable of producing.

There is necessarily a loss of weight caused by the process of cutting a gem. This varies considerably in accordance with the original shape, imperfections, and nature of the rough stone. A well-formed diamond loses quite half its original weight in the cutting.

The method of cutting diamonds differs in many respects from that used in connection with all other

precious stones; in fact, diamond polishing constitutes a distinct craft which forms the basis of an entire industry irrespective of other precious stones. The process consists of three different operations: "bruting," "polishing," and "cleaving."

Bruting. The bruting of diamonds consists of rubbing two diamonds together in such a way that by continual friction each can be made to assume the desired shape. Each diamond is cemented upon the end of

DIAMOND BRUTING.

a stick or holder about a foot long, and the operator firmly holds one end of each stick in either hand. The stones are then rubbed and pressed one against another over a wooden trough containing a very fine metal sieve, into which fall the particles of diamond dust rubbed from the stones. In order to obtain a sufficient leverage the holders which support the diamonds are held against little metal projections on either side of the trough.

The dust which falls through the metal sieve is carefully preserved and used later on for polishing purposes. The dust is known as "diamond powder,"

and has exactly the same appearance as slate-pencil dust. Thus upon the principle of "diamond cut diamond" the stones are roughly fashioned by the bruter into whatever symmetrical form he has designed them to be when finished.

Another method of obtaining the same result is to rotate one of the diamonds in a lathe and to literally turn it into the desired shape by means of the other stone held against it.

The small polished flats, known as facets, with which the surface of a diamond is covered, are added subsequently, this forming another part of the process.

When the bruter has completed his part of the work, the diamonds are handed to an attendant, who is seated at a bench in front of two flaring argand burners. Small brass basins, known as "dops," which vary in size from one to three inches in diameter are placed in the flames, and each dop is filled with a mixture of tin and lead in the proportion of one part of tin to two of lead. When this metal has assumed a semi-molten state, it is fashioned into the shape of a cone by means of a large pair of soft iron tongs, and upon the apex of which cone one of the bruted diamonds is carefully embedded.

Soldering.

After the diamond has been properly adjusted, the dop containing the cone of hot metal surmounted by the diamond, is plunged into cold water; the stone is thus firmly fixed, the dop forming a kind of holder for it.

The stone is now ready to be handed to the polisher, but it is necessary for it to be returned from time to time to be unsoldered and readjusted in order that a different part of the stone may be brought into

PROCESS OF DIAMOND POLISHING.

prominence, as it is only possible to work upon that part which projects from the metal. This operation

A SKEIF.

is repeated continually until the process of polishing is completed. The operation of embedding diamonds in the metal as I have described is known as "soldering."

An ingenious contrivance for obviating the necessity of using solder consists of a copper holder into which the stone is firmly fixed by means of a forked clamp which is pressed against the stone and locked into position with a key. The placing of the diamond in this holder requires, if possible, more skill

DIAMONDS HELD IN POSITION UPON THE WHEEL.

than is necessary to fix the stone in the cone of solder, for it is equally imperative that it should be adjusted at the correct angle.

Diamond polishing.

The polishing of diamonds is a laborious process, requiring the greatest accuracy. The craftsmen are seated, generally with their backs to the light, in front of revolving wheels, which are made of very porous cast-iron. The wheels turn in a horizontal position at about 2,500 revolutions a minute. The

technical name for a diamond-polishing wheel is "skeif." The dops containing the diamonds are held by means of iron clamps against the surface of the skeif, and kept in position by means of heavy weights. Four of these clamps are manipulated by each operator at the same time, and he is able

PLACING DIAMOND UPON WHEEL.

to examine first one diamond and then another, occasionally plunging each into cold water to prevent the heat generated by the friction unsoldering the stone, which would occasion considerable damage to the gem and loss of valuable time and labour.

The surface of the skeif derives its erosive property from the continual application of diamond dust **Skeif.**

mixed with olive oil and to the dust which comes off the stones undergoing the process. The facets are polished on to the diamond by means of pressure against this erosive surface, while it revolves at a high speed.

The diamond dust is prepared by means of steel

PESTLES AND MORTARS, FOR MAKING DIAMOND POWDER.

pestles and mortars in which fragments of boart, or coarse, valueless diamond are placed. By means of blows and great pressure upon the pestles, the desired fineness of diamond dust is obtained.

As the diamond dops are frequently too hot to hand from one man to another with comfort, even after having been plunged into cold water as already

described, wooden holders are used for the purpose of handling them more readily.

"Brilliant."

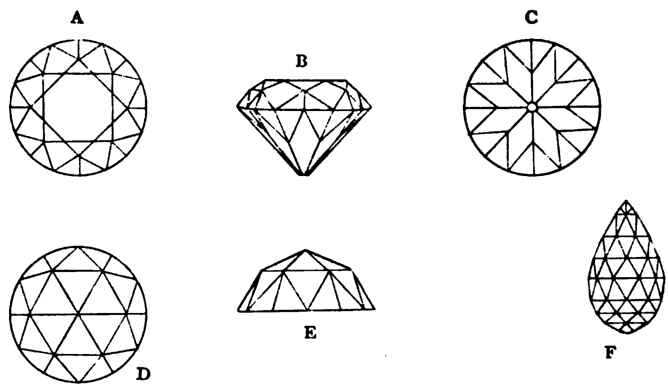
The "brilliant" is the usual form into which diamonds of any importance are cut. The front of a "brilliant" consists of an octagonal facet in the centre, termed the "table," which is surrounded by thirty-two smaller facets extending from the table to

WOODEN HOLDERS FOR DOPS.

what is known as the "girdle," or edge of the stone. The back of a "brilliant" is in the shape of a pyramid. A small facet at the extreme apex is known as the "culet," and there are twenty-four facets reaching from the culet to the girdle. The brilliancy of a "brilliant"-cut diamond is due to the refraction and reflection of light from facet to facet within the gem, and a well-cut "brilliant" should be so proportioned that a ray of light entering the stone from the front

is refracted about within the stone and out again from the front, thus causing the maximum of refraction.

"Rose." The "rose" is another form of cutting, which is, however, only used for small thin stones which are unsuitable for making into "brilliants." The front of it is covered with six or more triangular facets of equal size, and the back is quite flat. The effect obtainable from a "rose" cut diamond is very small



FORMS OF DIAMOND CUTTING.

A. Front of brilliant. B. Side of brilliant. C. Back of brilliant. D. Front of rose. E. Side of rose. F. Briolette.

compared with that of a "brilliant." As the "rose" is devoid of the pyramid which causes the lustre of a "brilliant" cut stone, it necessarily refracts the light in a very small degree.

"Briolette." The "briolette" is a pear-shaped diamond covered all over with triangular facets like the front of a "rose." It has neither "table," "girdle," or "culet," and is generally drilled across the narrow end in order that it may be worn swinging as a pendant or some other similar device.

Besides the three principal forms of cutting, which I have already described, diamonds are sometimes cut into what are known as "single cut" stones, that

DIAMOND CLEAVING.

is, brilliants without the full complement of facets; it is unnecessary, however, to say that diamonds cut in this way lack brilliancy.

Thin cleavage or slice-like pieces of diamond are

sometimes polished with one very large facet on either side surrounded, perhaps, with a few very small ones at the edge. Diamonds cut in this way are used to put in front of tiny miniatures, in which way they are mounted into rings and other jewels.

Diamond cleaving.

I have now to describe the process of cleaving diamonds. When it is necessary to divide a rough diamond into halves, or to remove a small projecting part from a large stone, advantage is taken of the property of cleavage, that is, the natural tendency of a diamond to divide along certain planes parallel to the faces of the octahedron. With this object in view the diamond to be cleaved is cemented upon the end of a wooden stick or holder in such a position that the plane of cleavage to be used in the operation lies parallel to the length of the stick, which is firmly fixed into the centre of a weight projecting from the wooden bench in front of the operator. A steel blade is held against the diamond in the desired position, and by means of a smart blow upon the back of it, the stone is caused to divide along the cleavage plane.

An accurate knowledge of crystallography is required for the successful cleavage of diamonds, which is always a most onerous operation, though to an onlooker it seems performed with the greatest ease.

Diamond sawing.

There is in use in Antwerp an instrument in the form of a circular saw, for the purpose of dividing diamonds. It consists of a small, thin metal disc, with an edge prepared with diamond powder. It is rotated at a high rate of speed, and the diamond is mechanically pressed against the edge of it. With this machine it is possible to cut through a diamond

CLEAVING AND BRUTING OF DIAMONDS.

in any direction. The process, however, sometimes takes as long as two or three weeks.

It is a curious fact that diamonds which have been sawn or divided with this instrument seem to lack something in brilliancy in the polished state when compared with gems derived from similar material

DELICACY OF TOUCH.

which has been only cleaved with the blade. An explanation of this has not yet been forthcoming.

The fashioning of what are sometimes called, but quite inaccurately, Oriental gems, is, as already mentioned, quite different from the process employed in connection with diamonds.

Oriental gem cutting.

Whereas diamonds are cut and polished by means of great pressure and friction, and as it were, by main force, emeralds, rubies, sapphires, peridots, etc., etc.,

are manipulated with a delicacy of touch combined with a perfection of technique which constitute the whole secret of successful gem cutting. Upon the end of a tiny holder which may be made of ebony, ivory, or hard wood, and about the size of a short penholder, the gem is firmly fixed by means of cement. The other end of the holder is held against

GEM FIXED UPON THE END OF TINY HOLDER.

a rest called a "jamb peg," which is securely fixed at the right-hand side of the "lap" or revolving disc, against the surface of which the gem is brought into contact. To the surface of the discs, made of metal, is applied an erosive material consisting either of diamond dust, carborundum or emery, according to the requirements of the work in hand at the moment. They measure about nine or ten inches in diameter and about one inch in thickness, and are revolved horizontally either mechanically by means

CUTTING RUBIES, SAPPHIRES, ETC.

of a crank held in the left hand, or by power conveyed from an electro-motor or gas engine.

The first part of the process consists of roughly fashioning the gem into somewhat the shape it is destined to assume, at the same time removing worthless and faulty parts, and afterwards of apply-

GEM HELD IN POSITION AGAINST THE WHEEL.

ing the numerous little flats known as facets with which most precious stones are covered. It is to the arrangement and design of these facets that the gem ultimately owes its brilliancy and lustre.

At this stage of the work the precious stone presents a very dull and uninteresting appearance, for although much study and skill have been bestowed upon it, the facets which the cutter has executed

with such great care, are still unpolished, and the gem is now handed to another craftsman whose duty it is to perform the process of polishing.

Gem polishing.

The work of the polisher, which is somewhat more mechanical than that of the cutter, first consists of gently pressing each facet one at a time to the

GEM POLISHERS' BENCHES.

surface of another revolving wheel. This is a matter of very great delicacy, for not only is it necessary to brighten or polish the facets without unduly enlarging them, but also the angles between the facets must be retained exactly as arranged by the cutter, to whose judgment the result of the entire work is attributable.

As in the process of cutting, so also in that of

POLISHING EMERALDS, RUBIES, ETC.

polishing, all kinds of unforeseen difficulties are apt to occur at any time. A tiny feather or flaw may widen, an edge or angle may grizzle (chip) or a vein prove troublesome. The craftsman of the greatest ability is he who can overcome with a nicety of touch and extreme patience such untoward events without devoting more of his time to the work than the value of the gem upon which he is operating at the moment warrants. It is very easy for a careless or incompetent polisher to entirely ruin the work of a most experienced cutter.

The discs used in the process of polishing are similar in appearance to those used for cutting purposes, but instead of having an erosive substance impressed into the surface, they are smeared with a polishing material, such as rotten-stone. In order that the polishing medium may remain on the wheel as long as possible, parallel scratches are repeatedly made with lumps of hard sandstone divergent from the centre of the edge. The discs used both in cutting and polishing vary in composition to suit the specific hardness and other peculiarities of the gems undergoing treatment. They are made of iron, brass, copper, lead, gun-metal, bell-metal, tin, pewter, etc.; also of wood, leather, and felt.

Forms of cutting.

As a general rule coloured stones are cut into much the same forms as those used for diamonds, although often greatly modified, and therefore a description of them is almost unnecessary. An exception must, however, be made of the emerald, which is nearly always cut square or oblong, and covered with facets having parallel straight lines between them. This is known as the "step-cut." There is, however, great licence for making all kinds

of fancy and original shapes, some of which are extremely effective.

It is always possible with a little ingenuity to

LAPIDARY'S WHEEL.

modify or alter the accepted conventional form of cutting to suit any particular stone, and it is in this connection that the craftsman with an artistic sense of proportion succeeds.

Another form of cutting precious stones is known as "en cabochon," that is, with a rounded surface. Stones cut in this way have the fronts made smooth,

SLITTING.

and generally have the backs flat, or nearly so. This form is always employed for opaque and semi-opaque stones, such as turquoises, chrysoprases, moonstones, opals, cat's-eyes, asterias (star-stones),

etc. Emeralds, sapphires, rubies, and many other coloured stones are sometimes treated in this way with excellent effect. Gems cut "en cabochon" are

ENGRAVING GEMS.

greatly used in Russian jewellery, and in certain artistic circles in London and Paris they are preferred to those cut in a more elaborate way.

Slitting. The process of dividing a stone into two or more pieces is known as "slitting." The method em-

ployed is to hold the gem stone against the extreme edge of a very thin metal circular plate, which is primed with diamond dust, and caused to revolve either vertically or horizontally.

This is an operation requiring much skill and judgment, for it is necessary for the plate to pass

LAPIDARIES' BENCHES.

through the stone in absolutely the desired direction, possibly from one projecting point to another without making the aperture or cut wider than the thickness of the plate. In the case of a gem of value, such as a ruby or an emerald, an error in judgment equal to the width of a hair is of importance. Slitting is performed by the Cingalese by means of a wire smeared with diamond dust and worked in the

manner of a fret saw, but this is a most tedious and unsatisfactory process.

Gem stones are drilled by means of a point made of a splinter of diamond or a "chenier," primed with diamond powder. The drill is rotated by means of a lathe or other device, and the stone is gently held against the revolving point at the desired angle.

Drilling and carving.

For engraving and carving gem stones, small discs of metal are rotated in the same way, the gem being held against the edge of the discs. The edges of these discs vary in shape, so that the character of the cut produced may be varied according to the requirements of the work in hand.

Some of these tiny tools are endowed with a cutting property by the application of diamond dust, carborundum, etc., and others are smeared with a polishing material for use in the subsequent process of polishing.

CHAPTER V

GEMS CONSIDERED COMMERCIALLY

THE market value of all precious stones fluctuates very greatly. This is chiefly due to two reasons, viz.:

Firstly, the discoveries of new sources of supply.

Secondly, the vagaries of fashion.

The discovery of new mines, etc., generally has the result of lowering the value of a gem unless great care be taken to regulate the supply upon the market. This is sometimes done successfully, as in the case of the De Beers diamond mines, but unfortunately it is not always possible to exercise this control. Sometimes two distinct discoveries take place at about the same time, and until some combination can be formed between them, the output from the two sources must enter into competition with each other, with the result that the market price falls. As an instance of this may be mentioned the pink tourmaline from California and Brazil. Beautiful gems from both these localities appeared almost simultaneously upon the market, greatly to their mutual detriment.

Fashion lays down arbitrary rules with regard to precious stones, as with most other things, and a gem which is highly appreciated at one time is scarcely thought of at another. For instance, the **Fashion.**

cat's-eye, which was a most fashionable precious gem some twenty years ago, is seldom asked for now, whilst the emerald is so greatly in demand that it has trebled its value within the same period.

Sometimes a passing fashion will give a fictitious value to a gem stone for only a few months or even weeks. This is especially noticeable with regard to the less expensive gem stones.

We can all recall the craze for chrysoprase, and a still more recent one for "turquoise matrix." The market value of either of these stones at the present moment is extremely small, but while the fashion lasted the supply was not equal to the demand, and the prices rose accordingly. At the time of writing all green stones seem to be in vogue—emeralds, peridots and olivines. Owing to these changes it is impossible to give the reader any quotation of the market value of gems, but in forming an opinion the following items are the principal considerations: colour, freedom from imperfections, proportion, weight and size; also, if the stones be cut, the craftsmanship must be examined. All precious stones

Value.

increase in value per carat as the size of the stone increases, and although no satisfactory rule can be given for making a calculation in this connection, the following gems may be mentioned as those of which the value increases the most rapidly, viz., emerald, ruby, diamond, sapphire and cat's-eye.

When precious stones are sent to London, or some other gem market, in the rough state, they are first cut and then divided into suitable qualities for sale. Many gems, however, are crudely cut by the natives of Ceylon before they appear upon the market, and these have to be recut before they can be used in

high-class jewellery. Much additional loss of weight is thus incurred by the stones being cut twice. The process of cutting gems is a somewhat expensive item in connection with precious stones. Not only does the lapidary make his charge for the work, but great loss of weight to the material is unavoidably incurred. The lapidary charges by weight upon the stones in their finished state, except with diamonds, which are charged upon the weight of the rough stones.

Lapidary's charges.

Gems are sold in small paper packets, known in the trade as "parcels." Papers of various colours are used to show off the different kinds of stones to the greatest advantage. Opals are shown on black and turquoises on yellow, and so on. It is advisable to remove the gems from the paper when contemplating a purchase, and to place the coloured paper on one side, in order to see the exact shade of colour of the gems. The colour of one gem is often affected by that of another, and in this way one is apt to be somewhat deceived. For instance, if one had been examining a parcel of emeralds, and quickly turned one's attention to peridots, the latter stones would appear quite yellowish, or if the peridots were seen first, the emeralds would seem quite blue.

Coloured papers.

Carat weight.

Gems are generally sold by the carat weight, which varies in different countries, but to such a very slight extent that it is of no great importance. The carat weight in general use in Great Britain is equal to 3.16831 grains troy, that is, 151.5 carats = 1 oz. troy. The weights used by gem merchants for weighing precious stones are numbered, 1,000 carats, 500 carats, 200 carats, 100 carats, 64 carats, 32 carats, 16 carats, 8 carats, 4 carats, 3 carats, 2 carats, 1 carat,

$\frac{1}{2}$ carat, $\frac{1}{4}$ carat, $\frac{1}{8}$ carat, $\frac{1}{16}$ carat, $\frac{1}{32}$ carat, $\frac{1}{64}$ carat. In recording the weight it is not considered necessary to reduce the figures to simple fractions. Thus, one might write a description of a parcel of gems: "five fine yellow sapphires 65 $\frac{1}{2}$ $\frac{1}{32}$ cts."

The cheaper varieties of gem stones, especially in the raw state, are frequently quoted by the gramme, or by the oz. troy. Turquoises are sold by the piece. For weighing gems of value, scales of great

A FEW WEIGHTS.

100 carats. 1 carat. $\frac{1}{64}$ carat.

delicacy are necessary, and the operation is performed with the care exercised in weighing poisonous drugs.

The word carat is said to be derived from "carat," a red bean, the fruit of a tree called Kuara, which seems to have been used in the earliest ages for weighing gold.

Offers. In dealing in precious stones, it is customary when making an offer for goods, to seal up the parcel, with the amount offered written on the paper. While this seal remains unbroken the offer holds good. If the offer be refused, the parcel is returned to have the

seal broken by the would-be purchaser, who is thus released from his obligation.

Sometimes it is necessary to estimate the weight

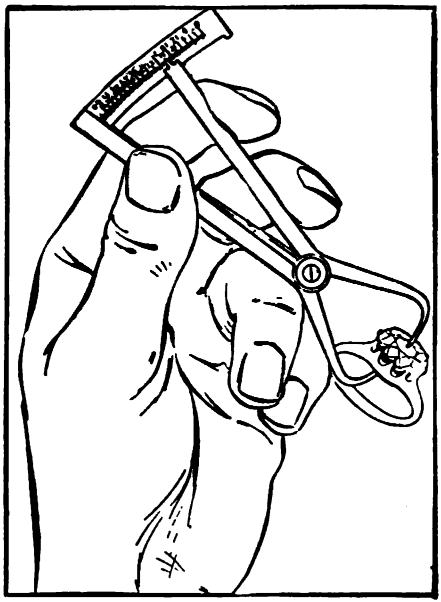
SCALES FOR WEIGHING GEMS.

of the stones contained in a diamond ornament offered for sale without the opportunity of removing the gems from the settings. It requires a great amount of experience to make such a calculation with accuracy, consequently the buyer is apt to make

an allowance to be sure that he is "on the safe side."

Diamond calculator.

An ingenious little instrument called the "Moe Diamond Gauge and Calculator," is of inestimable value for the purpose of making the calculation. With this piece of mechanism, which is of a most simple nature, it is only necessary to make measurements of the thickness and of the diameter of the stones to ascertain their exact weight. Certain arbitrary figures are indicated on the instrument, which are referable to a printed list giving the exact weight of the stones up to 7½ carats each. The instrument is, however, only for use in connection with diamonds, and does not calculate the weight of pear, marquise or other fancy shapes. The invention is of American origin.



"THE MOE" DIAMOND GAUGE AND CALCULATOR.

CHAPTER VI

EFFECTS OF FASHION UPON PRECIOUS STONES

WHAT a potent factor fashion is! We are all more or less subject to her sway; her arbitrary rules form laws from which we are unable to depart, although they often seem to come and go without apparent rhyme or reason, and to be the outcome of mere caprice.

Fashion is devoid of method with the one exception that she constantly works round and round in a circle, repeating what has been done before, and stopping to pick up things which she has dropped long ago and forgotten.

The decrees of fashion are perhaps felt more keenly by members of the artistic crafts than by any other part of the community, and it is to their benefit to pander to and supply whatever her wants may be.

There is no doubt that precious stones are subject to the changes of fashion in a very great degree, although there are other causes which affect their market value. Within quite recent years we have seen that all green stones have been in vogue. The series commenced with emeralds, which have continued to advance in favour; then came the inexpensive but delicately pretty chrysoprase; the olivine, with its verdigris green, was the next in order; to be followed in turn by the still popular Egyptian peridot.

Old-fashioned stones.

During the same period many gems which were known as "old-fashioned stones" when we were boys have been reinstated in popular estimation. Among these are, in addition to the peridot, the golden brown topaz (Brazilian) the sea-green and sky-blue varieties of aquamarine, the amethyst, and the rose-pink topaz.

Who can say that we may not find ourselves some of these days, again admiring the onyx and the carbuncle! Although it is impossible at present to perceive much beauty in them, fashion may again look kindly in their direction, and these, with similar stones, may again become *à la mode*.

There are many very beautiful gem stones which are almost unknown to the general public, but which from a purely artistic point of view, can vie with those stones which are most sought after.

The series of gem stones which consist of corundum not only includes ruby, sapphire, oriental emerald (green sapphire), oriental amethyst (purple sapphire), oriental topaz (yellow sapphire), but also gems of the greatest delicacy of colouring and great amount of brilliancy and lustre, which have become somewhat unhappily known as "fancy sapphires."

Unappreciated gems.

The range of colour and shades of colour in which these stones occur is practically unlimited; no collection of them can ever be considered complete. Not only do we find such colours as blue, yellow and purple, but there are soft and refined tones which can only be described by such expressions as silvery gray, pale lemon, lilac, peach pink, etc., etc. Certain varieties of the corundum gems possess the curious and beautiful property of changing colour when exposed to a different kind of light, in much the same

way as the alexandrite changes from green to red in natural and artificial light. I have seen such stones change from a peculiar steel gray to a decided raspberry red.

The asteria or star stone which also consists of corundum, exhibits a six-pointed star divergent from the centre to the edge of the stone. This curious gem stone occurs in several colours, the red and blue ones being the most rarely found. These are called respectively star rubies and star sapphires, but there are many of these stones which are pale and indefinite in colour, which cannot be included under these headings, and are simply called star stones.

The jargoon, or zircon, is another gem which is greatly unappreciated, and which, for its many decorative qualities deserves recognition. A wide range of colours also occurs in this gem, different specimens exhibiting a brilliant orange, a curious gamboge yellow, pistachio green, and very many shades of reddish-brown to golden brown, also dove colour and white. The brilliancy of this gem stone when skilfully cut is so very great, especially in the paler varieties, that it closely approaches that of the coloured diamond.

Flame red spinel.

The spinel presents also a large number of different colours, but, strangely enough, with only the exception of the red variety, they are seldom seen in jewellery. In addition to the red spinel, which too closely resembles the ruby to form a popular stone, there is the beautiful "flame red" variety which displays the extraordinary effect of a burning coal. A stone of this colour is, however, of very great rarity, and consequently highly appreciated by connoisseurs of precious stones.

There are spinels of many different colours which, although they may be described as a little "sleepy" with regard to brilliancy, may be regarded as most effective gem stones.

If fashion, by a turn of her wheel, would bring some of these really beautiful, but seldom heard-of gem stones into prominence, we should undoubtedly see some new effects in high-class jewellery.

The new gem.

It is so seldom that the discovery is made of an altogether new gem, that the announcement of the recent finding of kunzite at once attracted considerable attention. This gem, which has been proved to be a variety of the mineral spodumene, has become a favourite chiefly on account of its being a novelty. The stone presents a curious and pleasing peach-pink colour and a fair amount of brilliancy. Its slight resemblance to pink topaz and pale amethyst has, however, a detrimental effect upon its popularity. Nevertheless, it has attained a position of some importance, particularly in the land of its origin, America. Kunzite possesses the property of becoming fluorescent after exposure to the X-rays, but this does not add to its beauty as a jewel.

There are several very interesting gem stones which, in spite of being universally esteemed by all who have a knowledge of precious stones, have little chance of becoming the fashion for the simple reason that they are so rarely found.

The alexandrite, for example, is a most popular stone, but owing to the great difficulty of obtaining satisfactory specimens, it cannot be said to be fashionable. The fascination of this gem consists of the property of changing colour from green by daylight to red by artificial light. There are many to be ob-

tained which change from greenish brown to brownish red, but these are not at all appreciated. If really fine alexandrites could be obtained in moderately large numbers and in pieces of suitable size for use in modern jewels, there is no doubt that these would soon be found among the most fashionable of precious stones.

Another gem stone to which the same remarks apply is the curiously lustrous sphene. A fine sphene has only to be seen to be admired. It is a lemon yellow or cinnamon brown in colour, and possesses the power of dispersion of light to a wonderful extent. But the occurrence of this gem up to the present time is of such extreme rarity that a single specimen forms a curiosity. It certainly has the disadvantage of being very soft, so that it cannot withstand much hard wear, but even this drawback would not prevent it from becoming popular if a fair supply were forthcoming.

A curiosity.

Fashion seems to have her permanent favourites among precious stones, for diamonds, rubies, emeralds, sapphires, opals and turquoises are never completely banished from favour, although one or the other is for the time being placed in the foremost rank.

An abandoned gem.

A gem which has entirely lost its prestige in fashionable jewellery is the chrysoberyl cat's-eye. This beautiful and effective gem was in such great demand some fifteen or twenty years ago, that fine specimens fetched enormous prices, and large numbers were used in the form of every kind of jewel. Now, however, it is seldom seen at all, and even good specimens are with difficulty marketed. The stone consists of a variety of the mineral chryso-

beryl which, when cut *en cabochon*, displays a silvery shining ray or line down the centre of the gem. The body of the stone is green, brown, or yellow the first and last of these colours being considered the most desirable.

Unfortunately there is a worthless variety of quartz which has somewhat the appearance of the chrysoberyl cat's-eye. This stone does not approach the beauty of colouring and lustre of the true cat's-eye, yet the fact that it was mounted extensively in cheap jewellery may have had something to do with the decline of the cat's-eye in popular favour.

Jewels of our ancestors.

It is extremely difficult to obtain information with regard to the precious stones used in the jewels of our ancestors. A good idea of the form and design of the jewels can be gathered from the paintings of contemporary artists, but a knowledge of the nature of the material cannot be obtained in this way, for beyond a rough indication of the colour no impression is conveyed. Also, from inventories and lists of belongings of royal and notable people of the past, it is possible to gather but little information about the jewels of the different periods. There is no doubt, however, that much confusion with the different kinds of stones existed, for there is evidence of white sapphires and rock crystal being classed as diamonds, and garnets as rubies. Rubies, sapphires, carbuncles, emeralds, opals, garnets, onyxes, crystals were often mentioned and described, while the *balais* ruby or red spinel is included amongst the jewels of Queen Elizabeth.

The precious stones contained in articles of antique jewellery of nearly all periods are generally of a very insignificant nature considered from their

modern point of view. They generally consist of crudely cut garnets, crystal, pale blue sapphires and emeralds, but are fragmentary and of poor quality in every respect. Also the backs of the settings are closed in, so that any beauty which the stone may have possessed was not displayed to advantage. The backs of the gems were also originally painted in order to alter or improve the colour, although the pigment is often found to have perished with the course of time.

CHAPTER VII

GEMS AS AMULETS—BIRTH STONES, ETC.—GEM-STONES OF THE BIBLE

Magic.

AT a time when magic was a ruling power upon the earth, and superstitions now long exploded were the order of the day, it is not surprising that in those things which the infancy of science was not able to explain, men should suspect some hidden mystery and occult power, and that an easy credence should be given to all sorts of fancies and fictions regarding their nature and properties. Thus the rare stones and precious gems which by their rarity as much as their beauty became objects of interest, wonder, admiration and value; and concerning the origin and formation of which little was known, and that not widely, were well suited to excite the love of the marvellous and the belief in the supernatural which in ancient and mediaeval times held so powerful a sway over men's minds.

Talismanic powers.

To these precious stones were attributed properties and talismanic powers which, though in the enlightenment of the twentieth century they provoke a smile, were firmly believed in, in their day. And after all, some of these quaint old superstitions have died *so hard*, that to them can easily be traced many of the little halos which surround some of the precious gems used in our jewels to-day. Most of them

are innocent enough, 'tis true, and, at all events, afford opportunities for the display of pretty sentiments, besides forming an ever-useful subject of light conversation.

The following few notes will give the reader a fair idea of the quaint conceits associated with gem stones in the distant past. A few only will answer the purpose, as there is a great sameness about them all, particularly with regard to their absolute absurdity.

Probably the most ancient of all these superstitions is that connected with amethyst. This stone was supposed by the ancients to preserve the owner from the effects of drunkenness, and perhaps, after all, it was as effective in its way as the "gold cure" of which we hear so much nowadays. It was also considered a preservative against hailstones and locusts, and was said to produce sleep. If an amethyst bead were suspended on a hair from a baboon and worn at the neck, it was believed to keep away evil spirits and to thwart witches.

The chrysolite and the topaz possessed the power of cooling boiling-water; probably any other stone would have done as well for this purpose, though it might not have their additional virtue of cooling angry passions. These two gems were also believed to possess a power to which those who feared the secret treachery of their enemies turned for protection. If poison were suspected and one of these stones were introduced into the vessel, the presence of the subtle drug would so change its character that it would present the appearance of a piece of unpolished crystal or even glass, while in the absence of poison it would retain its natural brilliancy and

lustre, and the owner could drink his cup of wine with impunity.

Valuable as it undoubtedly must have been to have a ready means of detecting poison, it was still more important to be able to counteract its effect when taken inadvertently, and to this end the amethyst, the ruby and the diamond came to the wearer's aid. The last named, while affording protection to the wearer from the effects of poison, was also considered to be a poison in itself of the most deadly description. Cellini states that an attempt had been made upon his own life by introducing diamond dust into his salad, but that, fortunately for him, the diamond had been stolen and replaced by glass.

Another curious belief was that this precious gem, held in the mouth, caused the teeth to drop out. The diamond was enabled to deprive a loadstone of its magnetism, and shared with the *balais* ruby all the virtues of a lightning conductor. It was only necessary to touch the corners of a building with the latter stone to ensure its safety from the effect of lightning.

The diamond also was believed to influence the personal character of its wearer; magnanimity, virtue, and courage being amongst the attributes it engendered. Still more the man who entered upon a lawsuit would do well to wear the precious stone, for its effect would be to settle the suit in favour of the wearer. It is unrecorded what happened if both parties wore diamonds. Would it be the bigger diamond, or the greater number of diamonds that gained the day, I wonder! And even yet the wonderful powers with which the diamond is credited are not all told.

By it the power of magic and of witchcraft was overthrown, ghosts and devils were driven out, and last, but not least, the sleep of the happy possessor was never troubled by the gruesome nightmare. **Witchcraft.**

These last benefits might, however, also be obtained from the chrysolite so called, more probably, the stone that is now known as topaz. This stone, in order that the charm might be in operation, should be worn in a gold ring on the left hand. Devils fled from its presence when it was threaded like a bead upon the hair of an ass. As regards the wicked spirits and the nightmare, the ruby possessed the same potency.

Should one desire to be rich, a jacinth, it was believed, should be worn in a finger ring, and the usual accompaniments of honour and wisdom follow suit. This stone also was said to produce sleep.

The sapphire was another useful little gewgaw, for it was supposed to carry weight with princes, and all who wore the purple.

There is another stone, which, like the diamond, was useful in lawsuits in another way, but tending to the same end in the long run. If it were necessary to expose a false witness, one had only to confront him with an emerald, which immediately underwent some extraordinary change. The emerald was also supposed to give to the wearer the power of eloquence of speech. This gem also had another curious property. It struck snakes blind.

The possessor of the ruby was preserved from sadness and evil thoughts, and as a correlative enjoyed a cheerful temperament. The red spinel, known as the *balais* ruby, also possessed these vir-

tues, and added to them the enviable one of being a peacemaker.

There are two stones which were used as amulets against danger, viz.: the turquoise, whose power was chiefly exercised over the safety of equestrians, and the ruby, which was said to turn black if the owner were in danger, and if the gem had been a gift, also indicated the danger of the giver in the same way. Among the many superstitions relating to the turquoise, the prettiest is that, when given as a love token, its hue varied with the constancy of the lover. Some thought its change of colour merely indicated the health of the wearer, rather than the constancy of the lover, and others again thought they could read in it the time of day. Pretty fancies enough, but how far from the truth!

Love token.

There were many stones credited with direct influence over the physical health of the possessor. Some, like the ruby and the *balais* ruby, had the guardianship of the general health of the wearer, while others only possessed the power to combat some specific disease. For instance, diseases of the eyes might be cured by *balais* ruby powdered and stirred up in water and taken internally, while the eyesight was improved by staring at an emerald. The opal and the beryl had only to be worn to form amulets against diseases of the eyes. A prescription which was supposed to be a good liver tonic, was to drink the water in which a beryl had been rinsed. Hiccoughs were also stopped by the same means.

The "falling sickness," whatever that may be, found its sure cure in the emerald, and consumption in the moonstone. There was much less trouble and

inconvenience attached to this method than to the open air treatment now in vogue. It was only necessary to hang a moonstone round one's neck and wait for the new moon. Then during a fortnight the cure was effected, but the moment the moon was on the wane, the stone lost that charm and developed another still more remarkable. If after washing the stone, some of the water used for that purpose was held in the mouth without swallowing it, one was immediately endowed with the power of prophecy!

Luck. The opal, the fairy gem, was supposed by the ancients to share the charm of every gem whose colour it reflected; but strangest fancy of all, when stolen, the thief became invisible and was allowed to escape scot-free.

The notion that the opal brings ill-luck to the wearer is not nearly so ancient as many of superstitions related of other stones. It probably does not date farther back than the middle ages. The old word "ophal" for opal, which was used as late as Queen Elizabeth's days, was derived from *ophthalmius*, by which name this stone was known to the Greeks. The meaning of the word is eyestone, and as eyes are "unlucky," even in peacocks' feathers, perhaps an explanation of the superstition lies in the name of the stone.

Birth stones. A quaint idea, the origin of which I believe is unknown, is that certain gem stones have become associated with the months of the year, and each is considered a lucky talisman for those persons whose natal day falls within the month which it represents. These gem stones are called birth stones, and are as follow:

January . .	Garnet.	July	Ruby.
February . .	Amethyst.	August . . .	Sardonyx.
March . .	Bloodstone.	September .	Chrysolite.
April . . .	Diamond.	October . .	Opal.
May . . .	Emerald.	November .	Topaz.
June . . .	Agate.	December .	Turquoise.

Apostle stones. The following gem stones are said to be associated with the twelve Apostles (H. Emanuel, F.R.G.S.):

Peter . . .	Jasper.	Matthew . .	Chrysolite.
Andrew . .	Sapphire.	Thaddeus .	Chrysoprase.
John . . .	Emerald.	Thomas . .	Beryl.
James . . .	Chalcedony.	James the less	Topaz.
Philip . . .	Sardonyx.	Simeon . .	Jacinth.
Bartholomew	Carnelian.	Mathias . .	Amethyst.

Tribes stones. Also the twelve tribes of Israel are represented by gem stones, viz.:

Reuben . .	Carnelian.	Napthali . .	Beryl.
Simeon . .	Chrysolite.	Gad . . .	Amethyst.
Judah . . .	Ruby.	Asher . . .	Onyx.
Issachar . .	Sapphire.	Benjamin . .	Jasper.
Zebulon . .	Diamond.	Ephraim . .	Garnet.
Dan . . .	Emerald.	Manasseh .	Agate.

Gem Stones of the Bible.

The three following lists of precious stones appear in the Bible:

I. The Description of the High Priest's Breastplate. (Exodus, xxviii, 17-20).

Emerald.	Topaz.	Ruby or Sardius.
Sardonyx (Diamond—A.V.)	Sapphire.	Carbuncle.
	Agate.	Amber or Jacinth.
Amethyst.	Beryl.	Chalcedony or Chrysolite.
Jasper.		

II. The Covering of the King of Tyre. (Ezekiel, xxviii, 13).

Diamond.	Topaz.	Ruby.
Jasper.	Onyx or Beryl.	Chrysolite or Chalcedony.
Carbuncle.	Emerald.	Sapphire.

III. The Figurative Description of the Heavenly City. (Revelation, xxi, 19, 20).

Jasper.	Sapphire.	Chalcedony.
Emerald.	Sardonyx.	Sardius.
Chrysolite.	Beryl.	Topaz.
Chrysoprase.	Jacinth.	Amethyst.

The following is a list of all the gem stones mentioned in the Bible, together with the reference, and the probable modern names:

Biblical Name.	Reference.	Probable Modern Name.
Adamant . . .	Ezekiel, iii, 9.	Corundum.
Agate	„ xxviii, 19.	Agate.
Amethyst . . .	Revelation, xxi, 20.	Amethyst.
Beryl	Exodus, xxviii, 20.	Aquamarine.
Carbuncle . . .	„ xxviii, 17.	Emerald.
Chalcedony . . .	Revelation, xxi, 19.	Plasma.
Chrysolite . . .	„ xxi, 20.	Topaz.
Chrysoprase . .	„ xxi, 20.	Chrysolite.
Diamond . . .	Exodus, xxviii, 18.	Onyx or Jasper.
Emerald	„ xxviii, 18.	Carbuncle.
Jacinth	Revelation, xxi, 20.	Sapphire.
Jasper	Exodus, xxviii, 20.	Agate.
Ligure	„ xxviii, 19.	Jacinth.
Onyx	„ xxviii, 20.	Onyx.
Sapphire	„ xxviii, 18.	Lapis-lazuli.
Sardius or Sardine stone	„ xxviii, 17.	Ruby.
Sardonyx . . .	Revelation, xxi, 20.	Sardonyx.
Topaz	Exodus, xxviii, 17.	Peridot.

CHAPTER VIII

DIAMOND

Carbon.

THE diamond is almost pure carbon in a crystallized state, and being the hardest substance in nature occupies the position of No. 10 in the scale of hardness. In this respect, however, specimens from different localities vary to some considerable extent, and even stones derived from mines in close proximity to one another are not identical in hardness.

The diamond crystallizes in the cubic system, and generally occurs in the form of the octahedron or rhombic dodecahedron. Some rough diamonds have the appearance of being almost spherical, which effect is caused by their occurrence in a form composed of forty-eight faces, known as the six-sided octahedron. The fact that the diamond is among the few minerals which sometimes crystallize with convex or curved surfaces, adds to the almost spherical appearance of this form.

This gem frequently occurs twinned. The natural crystals are frequently marked with equilateral triangular depressions of various sizes and interlaced. The cleavage is highly perfect, and parallel to the faces of the octahedron. The fracture is conchoidal. Lustre, brilliantly adamantine; specific gravity 3.52; transparent to opaque in black specimens; exhibits

positive electricity when rubbed. The diamond is extremely transparent to the Röntgen rays.

Refraction. The refractive power of the diamond upon light is very great, and it also possesses in a greater degree than any other gem stone the power of dispersing the different coloured rays into which white light is split up, causing the beautiful prismatic hues that flash from a well-cut diamond, which are so characteristic of the gem.

ALMOST SPHERICAL DIAMOND IN THE "BLUE GROUND" (ACTUAL SIZE).

A diamond will burn in air or oxygen, producing carbonic anhydride, leaving an ash often retaining the form of the original stone, and according to experiments made by Sir William Crookes, F.R.S., consisting of iron, lime, magnesia, silica, and titanium; also, according to the same authority, the weight of the ash is seldom higher than 0.05 per cent., if the original stone be of clear crystallized quality. Many diamonds become phosphorescent upon exposure to radium, or to a high tension current of electricity in a vacuum.

Colour. The range of colour in which diamonds occur is considerable, including in addition to the colourless gems so familiar to every one, shades of varying

depth of yellow, orange, brown, blue, green, red, pink, puce, gray to black. Some of these colours are of great rarity in diamonds, notably the red, pink, blue, green, and orange, therefore, they command high, and in fine specimens, fancy prices. Diamonds exhibiting a decided shade of red, blue, or green, have aptly been described as the "élite of precious stones." Yellow, yellowish, and grayish diamonds are, however, unless they present a good depth of colour, not considered of such value as the limpid white ones, for they occur in great numbers and are depreciated in consequence, although frequently surpassing the average white stone in brilliancy.

Sometimes it is found that an apparently coloured rough diamond is almost white when the outer surface has been removed from it by the cutter, the colour being merely skin deep. This parti-coloured effect is more frequently found to be the case with green diamonds than with those of any other colour. Diamonds never exhibit more than one shade of colour in the same crystal unless a flaw or other imperfection contains some impurity causing a colour to be reflected into the stone. I once cut a diamond with such a flaw, containing a curious flesh-red stain, the remainder of the stone being quite white. By carefully cutting the diamond so that the flaw came in the culet, the stone when made into a brilliant had the appearance of a red diamond when viewed from the front; when held sideways or back upwards it was apparent that it was white with a red spot; but this stone was little more than a curiosity.

Parti-colour.

From the writings of Pliny and other ancient authors it is obvious that although the diamond was probably a well-known and highly valued gem under

the Romans, it was confused with the transparent and colourless corundum or white sapphire called by the ancients "adamas," which name had reference to its extreme hardness. Pliny, however, describes the stones derived from India and Arabia in such a way that there is little doubt that they, at all events, were actually diamonds. He alludes to the shape of them being like two whipping-tops united at the base, and sometimes as large as a hazelnut in size; **Adamas.**

THE "COLENSO" DIAMOND (ACTUAL SIZE). BRITISH MUSEUM.

SIZE OF BRILLIANT INTO WHICH THE "COLENSO" DIAMOND MIGHT BE CUT.

also the silvery, steely surface lustre is remarked upon. The form of the octahedron in which diamonds most frequently occur seems to answer this description, and there is no mistaking the peculiar lustre of a rough diamond, which he describes with accuracy. He, however, also describes another variety which was doubtless the white sapphire above referred to. He alludes to its resemblance in polish and natural shape to those of rock crystal; he also speaks of its great weight, and that it could be drilled with another diamond, clearly indicating that it was corundum (King).

Engraved diamonds.

The engraving of diamonds has been a subject of dispute among many connoisseurs of precious stones. Although there are recorded two or three instances of diamonds being engraved with portraits, notably those of Charles I and his Queen, I am tempted to doubt the authenticity of the statement.

Diamonds have certainly come under my notice which have been scratched upon the surface so that the polish has been removed in places, thus giving rise to a frosted or etched appearance, but this removal of the polish cannot be described as engraving, which must be a certain depth in order to place the design in relief.

Some of the large diamonds of historic renown were scratched in this way with Persian characters when in their primitive form.

I think it most probable that when one reads of an engraved diamond, whether it be in the Holy Scriptures or elsewhere, one may assume that the stone was probably a white sapphire or some other material with which the diamond has at all periods been confused.

Many and wondrous were the virtues attributed to this gem by the ancients. It was not only supposed to be magnetic, but also to counteract the effect of loadstone. In the form of powder it was considered a deadly poison, but the wearer of a diamond was nevertheless able to resist the effect of other poisons. It baffled the art of magicians and witches; it made the wearer bold and virtuous; repelled devils and evil spirits, and was thought to be of great assistance to lunatics. It was for these supposed virtues that diamonds and other gems were prized, the beauty of the stones being evidently of minor importance.

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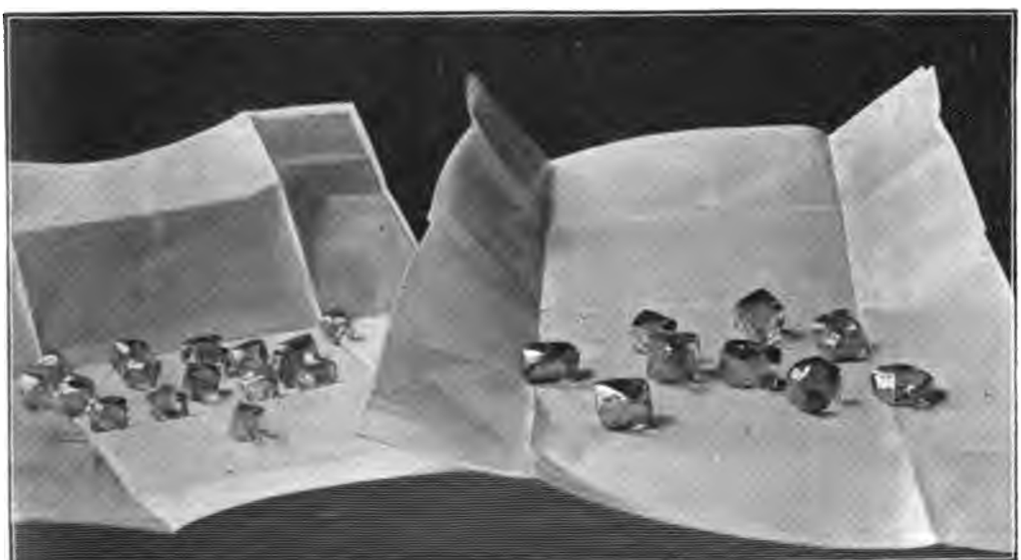
PARCELS OF ROUGH DIAMONDS (LESS THAN HALF SCALE).

The dark stones are of lower grade and are used for mechanical purposes.



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PARCELS OF ROUGH DIAMONDS.

At a very early period the diamond was cut and polished by the natives of India and China, by whom, however, the original shape of the stone was only slightly altered, owing to the difficulty of abrasion.

Rough diamonds as jewels.

Until the middle ages, owing to its extreme hardness, the diamond was not cut and polished in Europe, but was worn mounted in its natural state, which although lacking the lustre of the modern brilliant, possessed a peculiar beauty entirely its own. A fine example of diamonds treated in this way is the clasp of Charlemagne (Streeter), which was set with four large rough diamonds, and was probably an heirloom of his imperial family. It was not until 1460 that Ludwig van Berquen, a citizen of Bruges, discovered what is known to-day as the "brilliant cut." For particulars of the methods and forms of diamond polishing, etc., the reader is referred to another chapter.

At the present time the great source of diamonds is South Africa, where the chief diamond producing district extends from the angle formed by the junction of the Orange and Vaal Rivers on the northwest and south, to the twenty-sixth degree of longitude on the east.

In this district are situated all the most important mines, Kimberley and De Beers being almost in the centre.

South African diamond mines.

The output of the principal diamond mines of South Africa, which include De Beers, Kimberley, Dutoitspan, Bultfontein, Wesselton, and Jagersfontein, is under the control of the De Beers Consolidated Mines, Limited. The few remaining sources whence diamonds are derived are not of sufficient importance to upset the monopoly of the De Beers

Company. There are, however, vast diamantiferous areas in Griqualand West, Rhodesia, and in the neighbourhood of Pretoria in the Transvaal colony,

Nissen, Pretoria.

THE "CULLINAN" DIAMOND.

3,032 carats, or $1\frac{3}{8}$ lb. Size, $4 \times 2\frac{1}{2} \times 1\frac{1}{2}$ in.

outside the control of the De Beers Company, which contain several mines promising well for the future development of the industry in these districts. Of these, the Premier Mine, near Pretoria, is the most

prominent, and at this mine, the largest known diamond, the "Cullinan," weighing 3,032 carats, was discovered on January 26th, 1905.

The diamonds of each mine have their own special characteristics:

De Beers and Kimberley. Large crystals inclined to be yellowish.

Dutoitspan. Stones generally coloured.

Bultfontein. Small white stones, sometimes faulty, but seldom coloured.

Wesselton. Stones generally white, irregular, perfect crystals rare.

Jagersfontein. Steely white and of great brilliancy.

The material in which diamonds occur in South Africa is found filling up broad fissures and gaps by which the stratified rocks of the country are broken. It is considered that these fissures are volcanic pipes which have been filled from below subsequent to their formation by some volcanic agency. The depth to which they extend is unknown; that they are not all synchronous may be proved by the fact that the contents of different pipes vary somewhat.

Volcanic pipes.

It is, however, a moot point whether the contents of each pipe is the result of a single or of many volcanic eruptions.

Within the diamond-bearing material are included fragments of the surrounding rocks, and the fact that these, and also the edges of the pipes which come into direct contact with it, show little or no signs of decomposition, points to the conclusion that heat did not play a very important part in its formation.

The diamond-bearing earth, known to mineralogists as "Kimberlite," is found in three distinct stages, the lowest of which, called by the miners

"Hard Bank," is the hardest, and characterized by the fact that the constituent minerals are surrounded by zones, and that the rock is not greasy to the touch. Above this is a rock known as "Blue Ground," of a bluish colour, not as hard as the Hard Bank, but harder than the rock above it. Above this again is the "Yellow Ground," of a yellowish colour, very friable and greasy to the touch.

Blue ground.

It is supposed that the two upper layers is each a decomposed stage of the one below it, the colour being due to the presence of iron, which in the lower portions exists in the form of the lower hydrates, and in the upper has become oxydized by atmospheric influence. In all these layers certain minerals are found of which the principal are garnet, pyrites, calcite, magnetite, bronzite, olivine, ilmenite, and a variety of mica, while the ground mass is a serpentinous clay. Although these minerals are frequently found unassociated with diamonds, diamonds are never found except in company with them.

Associated minerals.

The different mines vary slightly in general character with regard to the various depths of the rocks of which they consist, and other geological differences which it is unnecessary to describe in the present work, and approximately the same method of securing the gems are employed at them all.

The original diggers at Kimberley had many difficulties to contend with, owing to the nature of the country, the difficulty of obtaining water, and the frequent falling-in of the sides of the mine. Owing to this last difficulty and the expense of removing the fallen rubbish, as the work progressed in depth it was found to be impossible to work the mine from the surface. Many holders of land were

then unable to proceed for want of capital, and the claims frequently changed hands, until eventually they all passed into the hands of the De Beers Company, who work them at the present day by a complicated system of tunnels.

Depositing floors.

Owing to the stubborn nature of the Blue Ground, after it is brought to the surface it is spread out to a depth of two and a half feet on fields many square miles in area, which have been properly levelled and prepared for the purpose, where, under the action of the atmosphere, it slowly disintegrates, the process being assisted from time to time by watering and harrowing. The time required for this process varies considerably, from a few months to one or two years; the most unyielding lumps are finally reduced by the crushing mill.

After the earth has become disintegrated, it is conveyed from the depositing floors to the washing plant, consisting of an elaborate piece of machinery which separates the heavy minerals from the lighter ones. The heavy material, among which are the diamonds, is then subjected to the action of the

Pulsator.

"pulsator," a very complicated machine which still further concentrates the diamond-bearing gravel. It was until recently then taken to sorting tables, where the diamonds were picked out by hand, the earth being first sorted by white men and afterwards by convict natives. It is, however, now passed through a machine called the "greaser," which consists of a shaking table made of five shallow steps. These steps are each coated with a thick layer of grease and the diamonds adhere to the grease while the remainder of the gravel is washed away.

The diamonds are cleaned by a mixture of nitric

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SOUTH AFRICAN DIAMOND MINING—THE "FLOORS," KIMBERLEY.

and sulphuric acid, and finally sorted into groups according to their size and colour, preparatory to exportation to London.

The penalties for illicit diamond-selling are very heavy, and mine owners still further protect themselves by the adoption of what is known as the "Compound System." A compound consists of a large square space about twenty acres in extent surrounded with a high iron fence. The natives are engaged on the understanding that they cannot leave the enclosure under six months. Houses are provided for them, and there is also a store at which all necessaries can be obtained at reduced prices; fuel and water are free, as is also the hospital. A swimming bath, and recreations in the form of concerts, etc., are also provided. On leaving the enclosure the natives are carefully searched. The whole area in which the work is carried on is also surrounded by a barbed iron fence; not only is it strictly guarded, but search-lights effectually prevent pilfering under cover of darkness.

Compound system.

The river gravels, old and new, on the banks of the Vaal, being *detritus* from the surrounding rocks, in many places contain diamonds, which have been washed from the diamond-bearing volcanic pipes. It was in these river gravels that diamonds were first discovered in South Africa, and miners are still always busy washing the gravels in a primitive way with often fairly satisfactory financial results.

River washings.

Diamonds found in the "river washings" are superior in quality to those mined at Kimberley, but the annual product of them does not exceed 1 per cent. of the production of the mines.

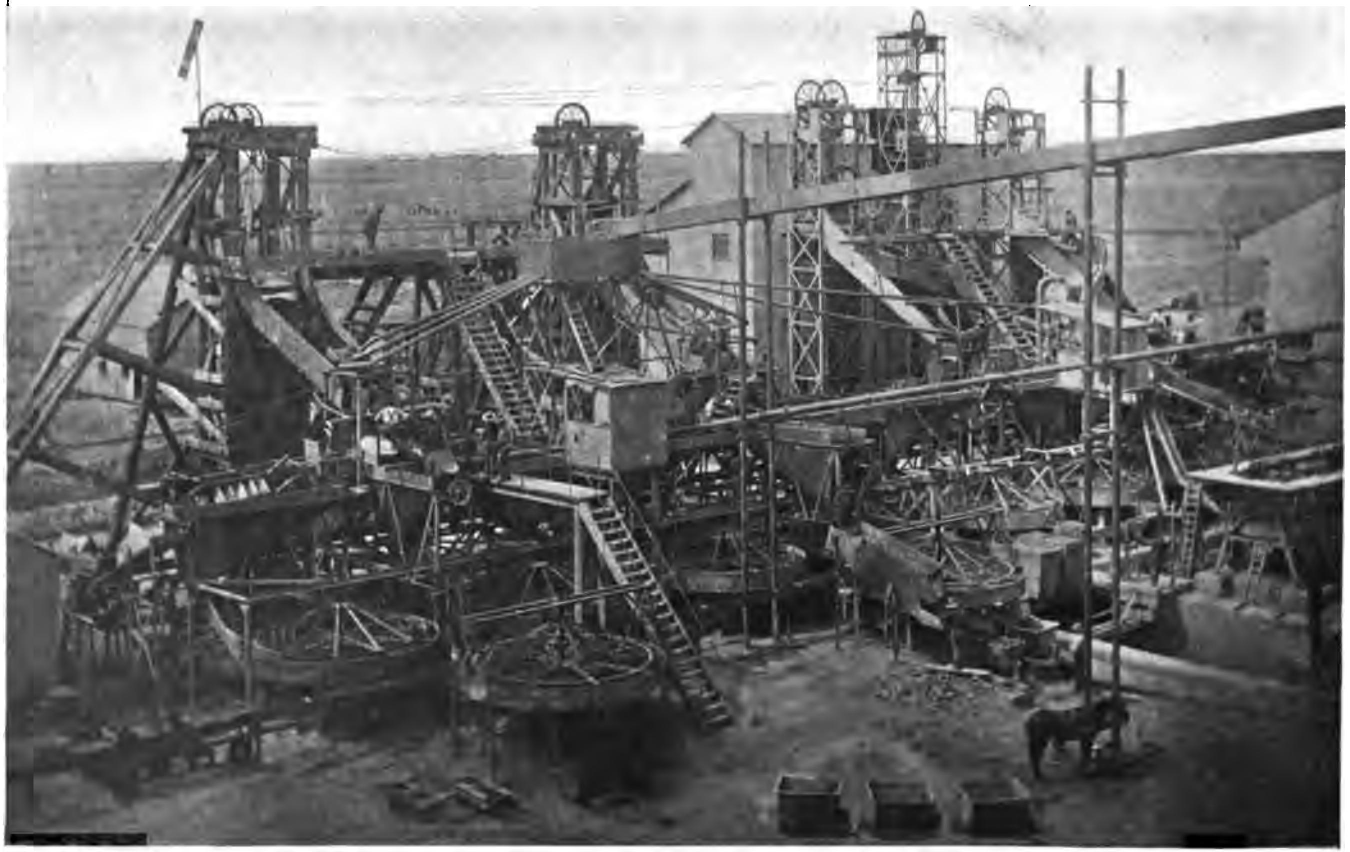
The story of the discovery of the first South

African diamond is a well-known one, but is of sufficient interest to bear repetition in these pages.

Story of first South African diamond.

In 1866 there lived on the banks of one of the small tributaries to the famous Orange River, a Dutch farmer named Jacobs. His farm was near the town of Hopetown, now so well-known to us all as a station on the railway between Cape Town and Kimberley. Mr. Jacobs was a married man, with children who loved the running water, as all children do, and were for ever playing by the side of the river, and delighting in the pretty stones which they constantly picked up on its banks. Some of these they carried to the house to use in their games at home, and among these was a very pretty stone which struck their mother as being unusually bright and of peculiar shape. While it was still in her mind as a matter of interest, a neighbouring farmer, Mr. Schalk Van Niekirk, called in to see Mr. and Mrs. Jacobs. In course of conversation Mrs. Jacobs casually mentioned this strangely bright stone, but had difficulty in finding it, as the children had been playing with it, and had left it somewhere in the garden; however, she at last found it and showed it to Mr. Van Niekirk. He, too, was interested in the curious stone, and thinking it might possibly be of value, offered to buy it from Mrs. Jacobs, who, however, merely laughed at the idea of selling a stone out of the river to an old friend, and immediately gave it to him.

Mr. Van Niekirk took it home, and shortly after showed it to his friend, Mr. O'Reilly, who was inclined to think it was valuable, and was struck with its bright appearance. He undertook to find out its value from some trustworthy mineralogist, if such



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SOUTH AFRICAN DIAMOND MINING—THE "WASHING PLANT," KIMBERLEY.

could be found. Mr. O'Reilly from Hopetown went on to Colesberg, where he talked about the stone, and cut his initials with it on the window pane of the hotel—I know not if it is to be seen there to this day, but the lookers-on at the time had no presentiment of the future in beholding this feat, as diamonds were unheard of in Africa in those days, and they supposed it merely a fragment of rock crystal which Mr. O'Reilly had picked up.

However, he himself had more faith in the value of the bright stone, and though laughed at for his foolish notion, was sure that he possessed a veritable diamond, and that, therefore, diamonds could be found in Africa! He next showed the stone to a friend in the district, who offered to send the stone for examination to Dr. Atherstone, a mineralogist of Grahamstown. The offer was accepted and the stone was sent by post in an ordinary gummed envelope, accompanied by a letter of explanation.

Dr. Atherstone carefully examined it, calling into his counsel Bishop Ricard, who was also something of a mineralogist. After testing all its characteristics, its degree of hardness, its specific gravity, and its appearance when subjected to optical tests, these gentlemen came to the conclusion that the stone could only be a diamond. This was in March, 1867.

Dr. Atherstone communicated with the Colonial Secretary, the Hon. R. Southey, upon whose suggestion the stone was forwarded in due course to Paris, where it was shown in the Exhibition of 1867. Here it was examined by the savants and mineralogists of all nations, who were unanimous as to the truth and value of the discovery. At the close of the Exhibi-

tion it was bought by Sir Philip Woodhouse, at that time Governor of Cape Colony, for the sum of £500. The weight of this diamond was $21\frac{3}{16}$ carats.

Such is the simple story of the discovery of the first of the bright and flowing stream of Cape diamonds of modern times.

Star of South Africa.

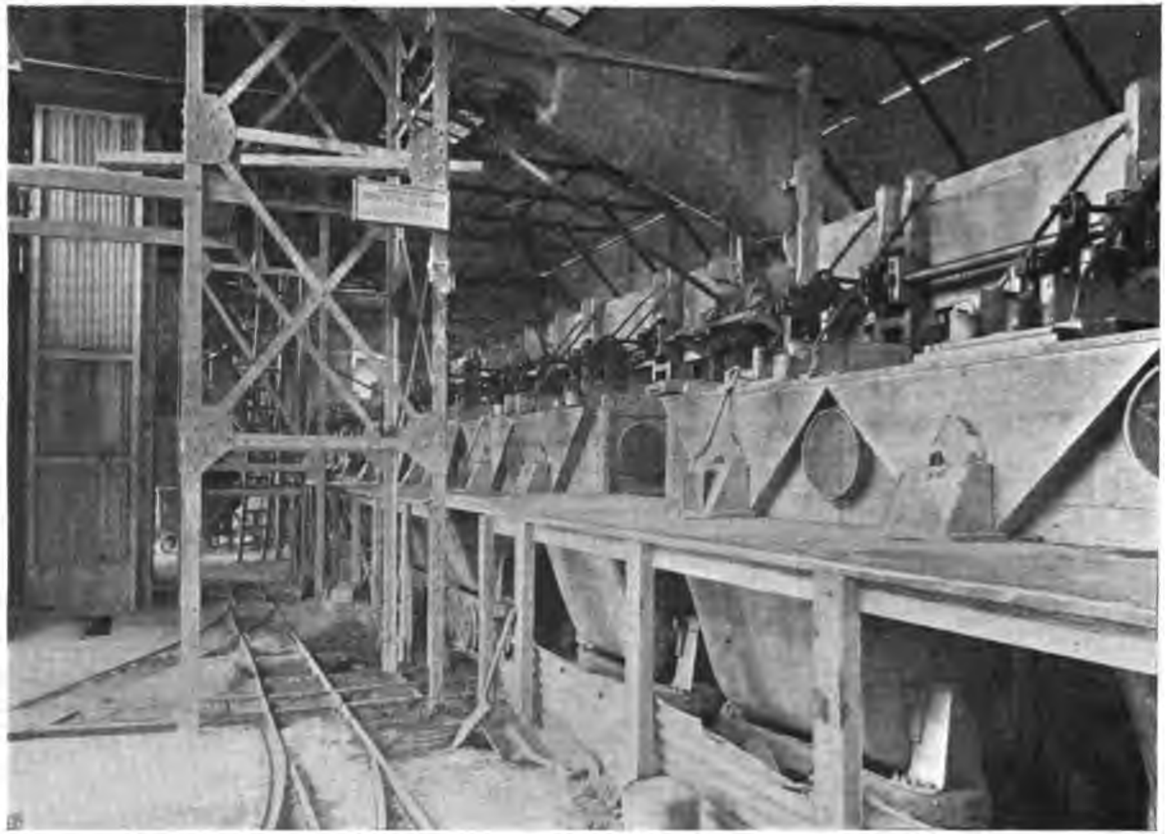
Mr. O'Reilly soon afterwards found a second stone weighing $8\frac{7}{8}$ carats, which realized £200. Mr. Van Niekirk also, shortly after this, got from a native who knew nothing of its worth a most valuable diamond, weighing no less than $83\frac{1}{2}$ carats, which he was able to sell even in Hopetown for the immense sum of £11,000. This stone afterwards received the name of "The Star of South Africa."

There is very little doubt that originally India supplied the world with diamonds, and most of the stones of historic interest have been derived from this source. But owing to the great facilities for obtaining a plentiful supply in South Africa, the industry has suffered in recent years both in India and Brazil, where diamonds were first discovered in 1728.

Indian diamonds.

The Indian diamonds are of a peculiar steely brilliancy, as in a somewhat less degree are the Brazilian gems, and there still exists a prejudice in favour of the diamonds mined in these countries, although South Africa has produced gems undoubtedly equal to them in every respect.

The principal areas in which diamonds occur in India are the districts between Golconda and Masulipatam; near Panna in Bundelcund; and in Ellore. The rock in which they are found is a quartzose conglomerate. The mining operations are of a primitive description, as modern machinery has not been



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SOUTH AFRICAN DIAMOND MINING—THE "PULSATOR."

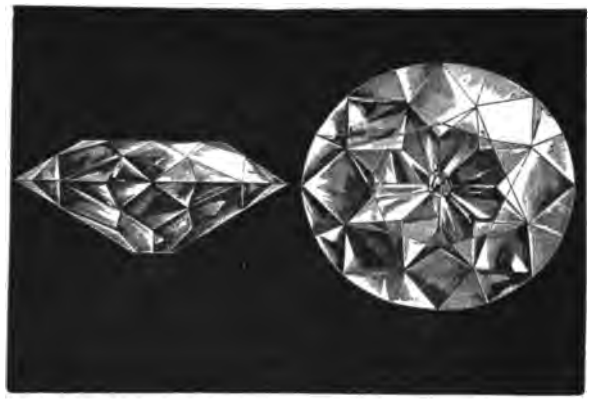
introduced because the Government does not grant sufficiently long leases of the various mines to warrant any great outlay of capital.

Brazilian diamond mines. In Brazil the most celebrated mines are situated on the Jequitinhanha River, known as the "diamond river," and the river Pardo, to the north of Rio Janeiro. According to Dana, the original rock appears to be either a kind of laminated granular quartz called "itacolumite," or a ferruginous quartzose conglomerate. The streams and small tributary rivers are turned in their course by artificial dams, and the beds are then carefully searched and washed for diamonds. Also on the banks of the large rivers, and in the courses of rivers which have shrunk in volume or dried up entirely, the washing for diamonds is carried on.

Diamonds of Borneo. Diamonds occur in a district west of the Ratoos Mountain in Borneo; they are frequently of a decided depth of colour and make fine "fancy stones." The industry of diamond mining has been carried on in a primitive way in Borneo for very many years, but owing to the difficulty of competition with the South African production it is now of little account. Russia and several of the United States of America may also be mentioned as producing diamonds in unremunerative quantities.

The diamonds occurring in New South Wales demand special reference, as they have attracted much public attention in recent years. They are found in various parts of the State, principally in the north, where several diamond mining companies are in active operation, those of the Inverell district being among the most successful. **Australian diamonds.** Up to the present time the size of the stones found is

very small, averaging about one-third of a carat; they are also so extremely hard that the process of cutting and polishing is very costly, which fact, coupled with their small size, renders them of little value for the purposes of jewellery; they, however, make brilliant little stones. Diamonds have also been found to occur in many other parts of Australia during the search for gold.



TWO VIEWS OF THE "KOH-I-NOOR" (ACTUAL SIZE).

British Guiana diamonds.

The occurrence of diamonds in British Guiana has been known for some years, and recently several companies have been formed with the object of developing the diamond mining industry in this colony; it is said that they are meeting with a fair amount of success. The district through which flows the Mazaruni River has produced nearly all the diamonds yet found in British Guiana. The gems greatly resemble in general appearance, also in the mode of occurrence, the diamonds of Brazil, where they are

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SOUTH AFRICAN DIAMOND MINING—THE COMPOUND, KIMBERLEY.

found in residual clays derived from the weathering of the country rocks.

According to the Government geologist, who has made petrographical studies of the rocks which occur in the various diamond-bearing districts of the colony, the country rock of these districts is quartz porphyrite and porphyrite changed locally to mica and chlorite schists intersected by dykes of granite and by later sheets and dykes of diabase.

That sapphires are reported to be found in company with the diamonds is of the greatest interest, as such is not the case in any other known diamond producing area.

At the present early stage it is impossible to predict the future of the industry in British Guiana, but if all, or even a great part of the published reports are true, there certainly appear to be brilliant prospects for the colony.

Famous diamonds.

The following are a few of the largest diamonds yet found, with particulars of weight and locality:

NAME.	WEIGHT AFTER CUTTING. (STREETER).	ORIGINAL WEIGHT.	WHERE FOUND.
Cullinan . .	—	3032 cts.	Premier Mine (Transvaal).
Excelsior . .	239 cts.	970 cts.	Jagersfontein (Orange River Colony).
Great Mogul .	279 cts.	560 cts. (estimated)	India.
Orloff . . .	193 cts.	400 cts. (estimated)	India.
Pitt (or Regent)	137½ cts.	410 cts. (estimated)	India.
Koh-i-noor . .	186 cts. reduced to 106 cts.	393 cts. (estimated)	India.
Star of the South . .	125 cts.	250 cts.	Brazil.

The three most notable coloured diamonds are the "Hope" Blue diamond, 44½ carats, the "Russian

TWO VIEWS OF THE "REGENT" (ACTUAL SIZE).

Red" diamond, 10 carats, and the "Dresden Green" diamond, 48¼ carats.

THE "HOPE" BLUE DIAMOND (ACTUAL SIZE).

Boart. Diamonds which are imperfectly crystallized or otherwise unsuitable for cutting into gems, are used for many mechanical purposes, such as drilling rocks, and in a powdered state for the cutting and engraving of many kinds of precious stones. Such diamonds are known as "boart." Those pieces which are spherical in shape are the most valuable for the drilling of rocks, and command a high price.

"Carbonado" consists of uncrystallized diamond and may be said to bear somewhat the same relationship to the diamond as emery does to sapphire. It occurs in irregularly-shaped fragments of a dark gray or blackish colour and is crypto-crystalline in structure. The hardness of carbonado is greater than that of crystallized diamond, therefore it is of great value for many abrasive purposes, such as drilling rocks, etc.; the specific gravity is slightly less than crystallized diamond. Carbonado is found associated with the diamonds of Brazil, but has not been discovered in India or South Africa. Ilmenite is a mineral which greatly resembles it in appearance, but is quite different in chemical composition, being a variety of titaniferous iron, while carbonado is a form of carbon. Ilmenite is found associated with the South African diamonds, and is erroneously known by the miners under the name of "carbon," but is of no commercial value. This mineral has frequently been substituted for carbonado, with desire to deceive the unwary. **Carbonado.** **Ilmenite.**

CHAPTER IX

CORUNDUM—RUBY

THE mineral known as corundum (from the Indian *Korund*) consists of almost pure crystallized oxide of aluminium.

Corundum. It crystallizes in the hexagonal or rhombohedral systems, and is generally found in six-sided pyramids, scalenohedrons, and prisms, although the coarse opaque variety also occurs massive and granular—that is, devoid of any natural crystalline formation.

In hardness, corundum is only inferior to the diamond, and therefore occupies the position of No. 9 in the recognized scale of hardness. It occurs both opaque and translucent, while its specific gravity varies between 3.90 and 4.16.

The opaque variety of corundum, which is generally dull gray, reddish brown or greenish, and sometimes colourless, is found in large masses in most of the Asiatic countries, and occurs plentifully in America and Australia. It is, on account of its extreme hardness, of value as an abrasive material, entering largely into the composition of emery. It is, however, the translucent variety of corundum with which we are chiefly concerned at present.

Colour. Every imaginable shade of every colour presents itself in this variety of the mineral, and the difference in the colour is due in a great measure to the addi-

tion of minute quantities of metallic oxides to the alumina of which the mineral is composed.

To many colours in which translucent corundum occurs a different name has become attached, *e.g.*, red corundum is called "ruby," blue corundum is

ROUGH CORUNDUM.

called "sapphire," the yellow, "Oriental topaz," the green, "Oriental emerald," the purple, "Oriental amethyst," etc., etc. Therefore, to the scientist, these gems are identically the same stone, only differing in an infinitesimally small degree in the nature of the colouring matter to which they owe their distinguish-

ing quality. But to the prospector, the dealer in precious stones, and the wearer of jewels, this little distinction with regard to colour makes a great difference, for upon it depends the commercial value of the gems.

Ruby

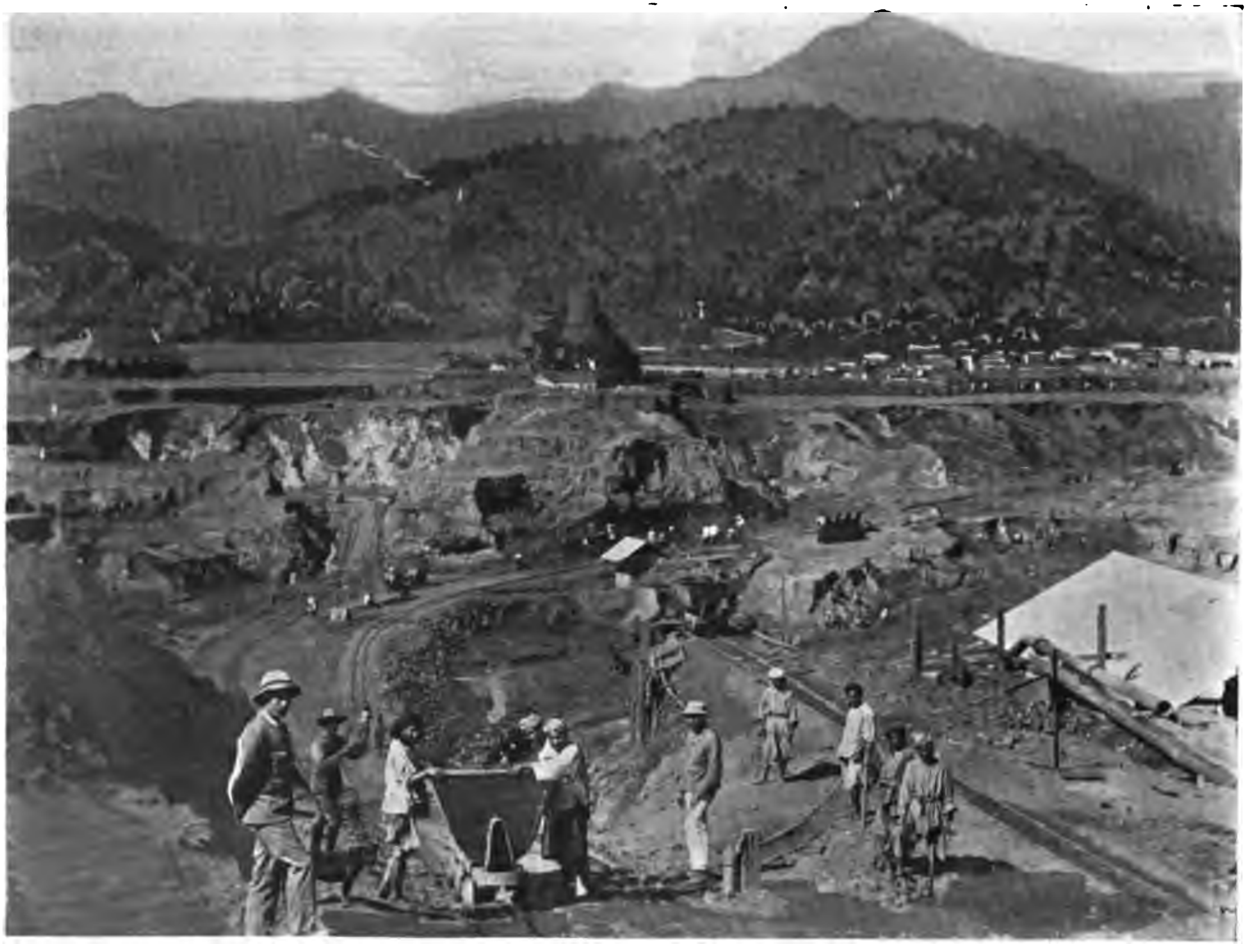
Ruby. The ruby or red corundum, is, perhaps, the most coveted of Nature's treasures by the human race throughout the universe.

In this most precious material it is possible to concentrate the greatest amount of wealth in the least possible bulk, for a ruby equal in value to a "king's ransom," can be carried in the corner of one's waistcoat pocket without inconvenience.

As already explained, the ruby is one of the group of precious stones which consist of oxide of aluminium and, consequently, has many of its properties in common with the other members of the same group. The specific gravity of ruby is 4. The hardness is generally recorded as 9, but as a matter of fact, ruby is slightly softer than the other corundum gems, which occupy the position of being next in hardness to the diamond; it should, therefore, be quoted as 8.5.

The ruby acquires electricity by friction and retains it for several hours. The lustre is vitreous, but the surfaces of the crystals are usually more or less dull. The fracture is conchoidal or uneven, and the cleavages basal, but imperfect.

Asteria, or Star Stone. Some specimens of semi-opaque and cloudy rubies display a shimmering six-pointed star when cut with a convex surface. These are called star rubies, and will be more fully described under the heading of Asteria or "Star Stone."



BURMA RUBY MINES—THE BOTTOM OF THE RAMP.

Ruby occurs in the hexagonal or rhombohedral system, assuming the form of the hexagonal prism, or pyramid. Water-worn and rolled and chemically altered fragments are, however, of much more frequent occurrence, often showing, by the absence of any trace of crystalline formation, how severe are the many hardships endured during the unrecorded ages of their existence. **System.**

Refraction. The ruby is doubly refractive, but not to a very great extent, and is always dichroic, showing the two squares of the dichroiscope of distinctly different colours—namely, crimson and scarlet—when viewed at right angles to the principal axis of the crystal. This is the most useful means of distinguishing ruby from garnet and spinel, which show both squares of the instrument of the same colour, no matter in what direction through the crystal they may be viewed.

WATER-WORN CRYSTAL OF RUBY (ACTUAL SIZE).

The occurrence of corundum in the form of ruby is extremely rare in comparison with the immense areas in different parts of the world, where the opaque coarse variety is plentifully distributed. **Localities.** There are three principal sources whence the rubies of commerce are derived, viz., Burma, Siam, and Ceylon, but they are also found in unimportant quantities in Brazil, Thibet, Queensland, Afghanistan, and in the United States of America.

The oldest tradition tells of rubies in the kingdom of Burma. But for centuries the ruby district was a *terra incognita* to the European traveller, for the land was as jealously guarded as some of the fabled palaces in fairy lore, which had for their sentinels

NATIVES OF BURMA BARTERING FOR RUBIES.

grisly giants or fire-spitting dragons. A few adventurous spirits were said to have entered the charmed ground, but they never returned, and their fate can only be surmised.

Burmese ruby mines.

From their earliest history, the Burmese monarchs kept a tight hold on these ruby mines. True it is

SORTING RUBIES IN THE BURMA RUBY MINES.

that they farmed them out to responsible lessees, but it was a hard and fast rule that every stone found above a certain size became the property of the monarch; moreover, if any mine promised unusually good results, the king would work that property for himself. We have evidence that the last king of Burma, the notorious Theebaw, had a liking for rubies, in the jewel-studded coats and ornaments which formed part of the Burmese regalia, which can be seen at the Indian Museum, South Kensington.

It seems certain that the king's claim to all the large rubies led to much pilfering and evasion, and that many fine stones were broken up, on the principle that "half a loaf is better than no bread." At the same time there is no doubt that rubies of large size are not of such frequent occurrence as are large diamonds in the diamond fields.

The British expedition to Burma and the subsequent annexation of the country by the British Empire unlocked the ruby mines, and in due time a company was formed to work them with modern appliances, and under scientific conditions. To the Burma Ruby Mines, Ltd., I am indebted for the accompanying photographs.

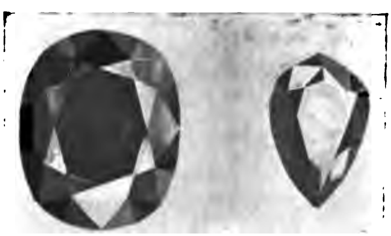
"The centre of the ruby mining industry of Burma is the town of Mogok, and the operations of mining extend over an area of upwards of four hundred square miles to the eastern bank of the Irrawaddy River. The rubies are found associated with garnet, graphite, and spinel in beds of coarse gravel, and embedded in more or less crystalline limestone which exists, alternating with gneissic and schistose rocks." (From a report by Professor J. W. Judd, C.B.)

The actual mining for rubies in Burma appears to be of a simple nature. Wherever the presence of the ruby deposit is suspected, shafts or tunnels are dug in the hill sides, and the material conveyed to be washed in the nearest available stream. The natural gullies, caves, and caverns are also explored and enlarged with the same object.

LARGE ROUGH RUBY (ACTUAL SIZE). ("EDWARDS" RUBY, BRITISH MUSEUM.)

The best stones are, however, said to be generally obtained from the valleys, where the deposit containing the rubies is often found at a distance of between twelve to twenty feet from the surface, varying in thickness from a few inches to five and a half feet.

Modern machinery.



THE "EDWARDS" RUBY COULD BE CUT INTO TWO STONES, THIS SIZE.

The application of modern machinery has made many changes at the mines, but the ruby-bearing material has still to be dug out in the same manner adopted by the natives. It is in the after treatment that scientific knowledge is brought to bear, and in the use of washing machinery, etc. But the greatest change is found in the more recent adaptation of the electric current to the ma-

BURMA RUBY MINES. WASHER, SHOWING UNDERGROUND STRONG ROOM INTO WHICH FALLS THE WASHED DEPOSIT FROM THE PAN

K

chinery of the mine. The modern dynamo has, in fact, worked the same revolution at the far-off ruby mines as it has been and is doing in so many different ways in Europe. By its aid, for example, the power of a distant waterfall can be utilized as easily as if it were close at hand. Washing machinery, pumps, drilling appliances, and all other contrivances, are now driven by electricity at a vast saving of both time and money.

The physical features of the country in which the mines are situated are well indicated in the accompanying photographs. It will also be noted that for carrying the ruby-bearing earth from the mines to the washing apparatus, etc., a narrow gauge railway is used, with small trucks, which are easily pushed along by the native workers. Each load of ruby-bearing earth yields, on an average, one carat of ruby, and the cost of its treatment has been reduced, since electricity was employed, from several shillings to about tenpence per load.

In Siam the most productive districts of rubies are Bangkok and Chantabun, on the Gulf of Siam. Another locality which produces large quantities of rubies is Korat, in which province the most important mines are situated at Bo Yan and Navoon.

Rubies of Ceylon.

The finest rubies in Ceylon are found in the district surrounding Ratnapura and Rakwena, in the detrital deposits of valleys, river beds, and mountain torrents, generally as water-worn pebbles, and broken fragments. They are always associated with the paler and many coloured varieties of corundum, which will claim our attention in due course.

The colour of the ruby varies very greatly, for, although it is characteristically red, there are innu-

merable different shades and degrees of depth of the colour in which this occurs. The tone of colour which is most rare and most sought after by connoisseurs in precious stones is termed the "pigeon blood" ruby, from its resemblance to the scarlet blood of a recently killed pigeon.

Burmese Rubies. The rubies which come from Burma more nearly approach this desired colour than those from any other country, and, consequently, are proportionately of greater value, but it is only in rare and isolated cases that a gem of the true colour is brought to light.

Siamese rubies. Siamese rubies are generally much darker than the Burmese stones, and have a tendency toward being purplish and puce in appearance. Although very occasionally a Siamese stone will bear comparison in colour with the rubies of Burma, the majority of rubies from Siam are of second-rate quality from a marketable point of view.

Ceylon rubies are different altogether from the rubies of either Burma or Siam. They are very limpid in brilliancy and pale in colour, possessing all the qualities of most beautiful and attractive gems, yet they do not rank among rubies of fine quality. These stones are greatly appreciated in France, and they are sometimes technically described as rubies of "French colour."

Cause of Colour. The actual cause of the flame-red colour of the ruby has been the object of most interesting investigation by Sir William Crookes and other great scientists of the day. Although it is believed that the many varieties of corundum derive their colour from the presence of most minute quantities of different metallic salts, it has comparatively recently been discov-

BURMA RUBY MINES—THE WASHING PLANT.

ered that the real cause of the colour of the ruby is still unknown. The absence of any salt of chromium, which was formerly suspected of causing the red hue in the ruby, has been conclusively proved by the most careful chemical analysis, and endorsed by the still more delicate method of spectrum analysis.

Sir William Crookes has demonstrated that when oxide of aluminium is inserted into a partially exhausted glass bulb, and exposed to the action of a high tension electric current, it flashes with a lovely crimson glow, and he has shown under similar conditions that ruby itself will give precisely the same result. Moreover, that if to the oxide of aluminium be added some oxide of chromium, the glow will not be produced; also, that if the light naturally transmitted (through absorption) by the ruby is examined by the spectroscope, it gives the same bands which are characteristic of the phosphorescent glow which comes from the oxide of aluminium in the vacuum tube. Another curious fact is that white oxide of aluminium, when exposed to electrical bombardment for a long time, gradually alters to a pinkish hue.

Altogether it is quite obvious that some mysterious property exists in connection with the oxide of aluminium, which the science of the day has not yet explained.

That the ruby has always taken the first place among precious stones is evinced by many references to this beautiful gem by writers of all ages, although, before the development of the science of mineralogy, great confusion seems to have existed with regard to rubies, as with many other precious stones. It is apparent that almost any red stone was classed by

the ancients under the general heading of "carbunculus," which doubtless included spinels, and all the many different kinds of red garnets, as well as the true ruby or red corundum.

Carbunculus.

Pliny, for instance, when he gives the first rank to the "carbunculus," describes under this heading many of the chief characteristics of the true ruby of to-day.

The "Pantarbes" of Philostratus was undoubtedly the modern ruby, and the gem alluded to by Theophrastus, as "Anthrax," was also probably ruby, for he writes of its great value, whereas garnets were so common that their value could not have been great at the highly civilized period of which he wrote. Both the words "Carbunculus" and "Anthrax" were used in allusion to the "burning coal" effect of the stones described.

The quotation, "For wisdom is better than rubies," one of the many references in the Holy Scriptures to this precious stone, proves that rubies were of considerable importance at the time of King Solomon, to whom the words are attributed.

From old writings we learn that by the ancients the ruby was always enveloped in mystery, and accredited with all kinds of strange properties, one of the most striking being the idea that the stone possessed the power of shining of its own accord in the dark, emitting flashes of light dazzling to behold.

Quaint superstitions and beliefs.

It was also supposed to attract other gems in much the same way as a magnet attracts steel. Thus, if a ruby were tied to the end of a string and lowered into a river, containing precious stones, it would be found upon its withdrawal that the ruby

VIEW AT THE BURMA RUBY MINES—BEFORE FLOOD TIME.

VIEW AT THE BURMA RUBY MINES—AFTER FLOOD TIME.

would be encrusted with other gems which had been attracted to it—a most useful virtue indeed!

Ruby was used as a talisman against all kinds of ills, but chiefly against fire, which virtue is illustrated in the legend of Chariclea, who, when condemned by the jealous Arsace (Aethiop, viii, 2), escaped unhurt from the pyre by means of an amulet in the form of the espousal ring of King Hydaspes, "which was set with the stone called Pantarbes, engraved with certain sacred letters embodying, as it has proved, some divine charm by which a virtue is imparted to the gem antagonistic to fire, and thus giving to the wearer immunity from hurt in the very midst of flames." (King.)

A peculiar idea, not altogether restricted to bygone civilizations, is that the different corundum gems alter or ripen in the earth, and that a ruby has changed gradually from yellow to blue, from blue to purple, and from purple to red, which might be looked upon as the perfection state, which the blue, yellow, and purple varieties of corundum have not reached.

Referred to by Cellini.

We know that the ruby was the most highly-prized of all gems at the period of the Renaissance, for Cellini, in his "Orificeria," referring to the relative values of precious stones, gives the value of a carat ruby as eight times that of a diamond, and eighty times that of a sapphire of the same weight.

Many are the tales of immense and magnificent rubies seen by travellers of old to the Courts of Asia. As these writers generally describe not only what they saw, but what was described to them, it is wise to take many of their statements with the

proverbial grain of salt. We find, for instance, allusions to "a ruby of perfect quality as large as a hen's egg, which was worn as an ear drop by the King of Ava."

Even Tavernier, in his "Travels," although im-

BURMA RUBY MINES—THE DAM IN FLOOD TIME.

parting much valuable information about the gem-producing countries visited by him, and the life and customs of the inhabitants, often taxes our credulity with regard to the gems he describes. But I think we may place reliance upon his account of a fine ruby in the possession of the King of Vishapoor, which he describes as being irregularly octagonal in

Rubies seen by travellers.

shape, of a most vivid red colour, and of about fifty carats in weight.

Some of the most notable gems in the Royal and Imperial regalias of Europe are rubies, but besides these, magnificent rubies from time to time appear upon the market, either in the rough state from the mines of Burma, or in a crudely cut form from the treasury of an Eastern potentate. These latter gems, which, perhaps, have been worn by hundreds of generations of their Royal owners, or which formed part of the splendour of idol or Buddha, are parted with to relieve some financial crisis of the Court.

Rubies of great size.

Mr. E. W. Streeter mentioned in "Precious Stones and Gems" two fine rubies which appeared upon the London market in 1875. After being re-cut, they weighed respectively $32\frac{5}{16}$ and $38\frac{9}{16}$ carats.

Ruby is seldom selected as an object for carving or engraving upon, chiefly owing to the extreme hardness of the stone. The great intrinsic value of this gem also makes it an unsuitable material for the purpose, as the artistic conception of design and execution of workmanship should claim the first consideration with these works of art. Occasionally, however, to meet the requirements of some wealthy client, the gem engraver of all periods has used the ruby as a foundation for intaglios and cameos.

Engraved rubies.

It must be said that among engraved gems of authentic antiquity, precious stones of all kinds are extremely rare, as productions of the most famous glyptic artists of ancient Greece were executed upon material selected as most suitable for displaying to the greatest advantage the inimitable genius of the period for cameo and intaglio, and for giving a true impression when used as a seal.

The full face of a Bacchante forms the subject of the most beautiful antique intaglio upon ruby known to connoisseurs. The exquisite treatment of the flesh and hair, as well as the expression of the countenance, denote the work of an artist of the first rank, ΕΛΛΗΝ by name, at the period when Greek glyptic art was at its height.

Other examples of the use of the ruby by ancient Greek artists are the head of Hercules upon a small stone of a pale colour in a very bold effective style, and a magnificent head of Thetis upon a pentagonal ruby of irregular shape. The latter subject is treated in a masterly way, depicting Thetis wearing the shell of a huge crab in place of a helmet. Both these intaglios have the heads engraved in profile. For the description of these two carvings I am indebted to the late Rev. C. W. King's "Antique Gems."

With regard to engraved rubies and other precious stones, especially of modern production, careful scrutiny will frequently show the presence of some flaw or other imperfection within the gem, which it has been the object of the glyptic artist to hide as far as possible.

Rubies made by man.

My notes upon ruby cannot be considered complete without reference to the scientifically manufactured rubies, although such do not, strictly speaking, come within my subject.

These products of the laboratory possess all the characteristics of the natural gem, but, however, contain peculiar circular markings within the stone, as if the stone had once been liquid, and whilst being rapidly stirred, had dried suddenly.

Such indications are never seen in the true ruby, and, moreover, the "manufactured rubies" are

generally a peculiar tint and are almost devoid of any diversity of colour.

From a scientist's point of view, they are undoubtedly rubies, but on the other hand, they are the result of man's efforts to imitate a natural product, and as such do not come within the definition of "a precious stone." See Chap. XXV, page 269.

CHAPTER X

SAPPHIRE

THE expression used by connoisseurs of precious stones to describe a sapphire of the finest quality is "Cornflower blue," or "Royal blue." **Colour.**

The resemblance of the stone to the familiar flower is immediately apparent when one looks at a fine specimen of this beautiful and popular translucent gem. Sapphires of this quality are, however, extremely rare, and always in great demand.

Innumerable different shades of blue exist, ranging from the perfection colour described, through countless imperceptible degrees of depth of colour, until only the faintest possible shade of the characteristic hue can be perceived.

Also the colour ranges in different specimens in the opposite direction through more or less intensely blue varieties, until it is so dense as to appear black. The sapphires which approach nearest to the desired colour are proportionately valuable. As the sapphire exhibits the property of dichroism in a marked degree the stone should be cut whenever possible with the table at right angles to the principal or optic axis of the crystal in order to obtain the true blue colour.

Many sapphires are what is technically known as parti-coloured—that is, the colour, instead of being **Parti-colour.**

quite evenly distributed throughout the stone, occurs in patches. Thus one part of the same stone may be white, while the other end is blue, or sometimes a blue stone has a blackish or even a red patch within it. These defects all have their effect upon the colour of the gem when cut and polished. The white patches create a watery appearance, the black, an inky one, while a spot or streak of red in a sapphire causes a purple hue to be reflected into the stone, and the presence of yellow causes a green effect, especially by artificial light.

PARTI-COLOURED SAPPHIRE.

There are many imperfections occurring in sapphires as in other gems, such as flaws, feathers, and milkyness, or spots and lines of opacity and semi-opacity.

Fashion in sapphires.

The sale of sapphires during the last few years has been much affected by the caprice of fashion which, as unfortunately is not always the case, has followed the dictates of common sense and good taste.

Formerly a sapphire was considered of fine quality if of an intensely dark blue colour, no matter if only a glimpse of colour was occasionally reflected from an otherwise black stone it was considered "a fine dark sapphire." Such a stone formed a most ineffective jewel, and by artificial light was useless as an ornament.

Although partiality still exists among the owners of family jewels in favour of these dark sapphires, they are no longer appreciated by the buying public,

who will have sapphires of a distinct and lively blue, the effect of which can be seen from as great a distance as the glow of the Burmese ruby.

Although the geographical distribution of sapphire is considerable, the sources whence the gem market is supplied are few in number. Siam, Burma, Ceylon, Kashmir, Australia, and Montana of the United States of America, are the principal sapphire-producing districts of the world. The gems derived from each of these localities vary in character to a greater or less extent, so that those persons who are familiar with precious stones are able to form an opinion of the source whence any sapphire was derived solely by its appearance. **Localities.**

The sapphires from Siam are of the finest quality obtained from the East. They approach in colour closely to the cornflower blue, and most of the finest sapphires of note owe their origin to this country. Of course large quantities of gems of inferior colour and quality are also mined in Siam, in fact a really fine Siamese sapphire is comparatively a rarity.

Siamese sapphires.

The principal sapphire mines of Siam are situated in Korat, Battambong, and Pailin, the latter being the most productive.

The sapphire-bearing stratum consists of a gravelly clay which is found at about ten or twelve feet from the surface, usually about ten inches in thickness.

In order to reach this stratum, pits are dug out and the clay carefully washed, the sapphires being afterwards picked out by hand.

Burmese sapphires.

Burmese sapphires are of much darker colour than those from Siam, but many fine gems have been mined in Burma. The majority, however, are inky in appearance and unpleasing to the eye on account

of their intensely dark colour. In association with the rubies of Upper Burma, sapphires are generally found in more or less remunerative quantities.

Ceylon sapphires.

Ceylon produces, associated with such gems as jargoon, spinel, chrysoberyl, and tourmaline, a great variety of most interesting corundum gems, the blue sapphire being perhaps the most important. The sapphires of Ceylon are, with a few exceptions, pale in colour, and although possessing remarkable brilliancy, seldom compare with the Siamese stones. Moreover, the sapphires of Ceylon are frequently very parti-coloured.

In Ceylon the gems are found in the gravel which formed the beds of ancient rivers. The rivers and mountain torrents ages ago washed the gems from their original position and rolled and turned them into water-worn pebbles, in which state they are found by the natives to-day, although the rivers have often ceased to exist, leaving, perhaps, just a sluggish stream to mark their former hurried course.

Kashmir sapphires.

Kashmir sapphires are mined at Banskor in large quantities, but are generally pale in colour, though very brilliant and effective gems nevertheless. Occasionally an unusually fine specimen is obtained from this country which can hold its own with the products of Siam and Burma.

Australian sapphires.

Queensland and New South Wales produce sapphires of enormous size and in large quantities. They are, unfortunately, with few exceptions, of little use in jewellery as the colour is generally such a very dense blue as to appear almost black when they are fashioned into cut and polished gems. Occasionally a very dark blue stone will have a white centre or core, which can be so manipulated by a skilled

lapidary as to allow the light to penetrate the darker portions of the stone. I have successfully cut many such gems with most satisfactory results. The yellow and green sapphires of Queensland are very beautiful and are fully described elsewhere.

A large Queensland blue sapphire, measuring over an inch and a quarter across, was fashioned by me into the back case of a watch with great success, as by this means the stone was made thin enough for the gold interior of the watch to reflect the light, giving the effect of a fine cabochon sapphire watch-case.

It is a very curious and noteworthy fact that the sapphires of Australia are harder than those from other localities, as also are the diamonds from the Commonwealth harder than all others.

Montana sapphires.

By far the most important precious stones mined in the United States of America are the beautiful blue sapphires which have been found within the last few years in Montana. Formerly only the pale, delicate tints of bluish-green, yellow, and pink varieties of corundum were produced by this State, and although immense quantities of these stones are obtainable, they are of small commercial value on account of their unmarketable colours.

In 1895, a company was formed to work the gold-bearing gravels found in pockets in the district east of the Yogo fork of the Judith River. After a great expenditure of capital in building a ditch to carry water to the locality in which the operations were in progress, it was found that the gravels would not yield sufficient gold to pay the expense of mining. It was noticed, however, that the sluice boxes contained a great many blue stones which were shortly

afterwards identified as sapphires, many of considerable value.

In the February of the following year a settler named John Ettien discovered a fissure in the limestone, the soft clay fillings seeming to resemble the outcrop of a vein. Some of this soft material was carefully washed, and sapphires were found. It was subsequently found that the sapphires occur in a dyke of trap rock cutting through the limestone. This dyke extends for a distance of about five miles from the canyon of Yogo Creek, eastward to the meadows of the Judith River.

A slight depression about a foot in depth, covered with grass and verdure, forming a contrast to the bare limestone which it traverses, is an indication upon the surface of the country of the presence of the dyke, also the badgers and gophers have made their holes in the soft material of the dyke, as the neighbouring limestone is too hard for them to bore into, thus forming another means of tracing it. In the little heaps of earth thrown up by these animals many fine gem stones have been found.

"New Mine Sapphires."

These gems are now known on the market as the "New Mine Sapphires." The entire output is shipped to the agents of the company in London, where the stones are cut and sold to the wholesale gem merchants. Strangely enough, large quantities find their way back to America, where they are greatly in demand. Several less important deposits of these American sapphires have since been discovered in the neighbourhood of the original mines. The mines are situated in Fergus County and are only accessible by wagon from Utica, a town thirteen miles distant. The material in which these sapphires

occur, varies very much in appearance and character, from the hard trap rock down through different

MONTANA SAPPHIRE MINING—CUT AFTER A SEASON'S WORK.

gradations to the soft yellow clay, into which the rock finally decomposes. A clay somewhat resembling the blue ground in which diamonds occur at

Kimberley produces a large proportion of the gems. The method of securing the gems is the same used in alluvial gold mining. A jet of water is directed against the lead matter, which is cut and dissolved into loose mud. The latter is washed through a long

Method of securing the gems.

WASHING FOR "NEW MINE SAPPHIRES."

series of wooden boxes; across the bottom of these boxes are placed riffles—pieces of iron two and a half inches high—and between them the sapphires remain, owing to their high specific gravity, whilst all the lighter mud and gravel are washed away.

In dealing with the harder rock more difficulty is

experienced in recovering the sapphires. It is first exposed to the disintegrating effects of the atmosphere, which cause it to become slack and easily

MONTANA SAPPHIRE MINING—WOODEN BRIDGE CARRYING PIPES TO THE WORKINGS.

pulverized; it is then washed in the sluice boxes and the sapphires saved.

Owing to the severity of the winter it is impossible to wash for the stones except between May and October, but during the remainder of the year under-

ground mining is carried on. The sapphire-bearing material is brought to the surface and washed in the following summer. I am indebted to the "Fergus County Argus" for particulars of these sapphire deposits.

Absence of many imperfections.

All kinds of precious stones, as already mentioned, sometimes contain flaws, feathers, and other imperfections, their successful removal or reduction depending upon the skill and judgment of the lapidary. The most difficult fault with which the lapidary has to contend in sapphires is the presence of cloudy and semi-opaque patches within the stone, often occurring in parallel lines which generally form a series of hexagons or triangles one within the other. This defect often mars the beauty of an otherwise magnificent gem, and by its removal immense loss of weight is incurred, not infrequently accompanied by deterioration of colour. The "New Mine Sapphires" are quite free from this tiresome defect of cloudiness, which is undoubtedly the reason of their great brilliancy and lustre.

Colour.

With regard to the colour of these gems, they range from the palest steel colour through all the different shades of steel-blue until they reach in the very fine specimens that lovely hue called "cornflower blue," which until comparatively recently was associated only with the sapphires of Siam, Burma, and Ceylon. Moreover, and this is particularly striking to a practical gem cutter, the colour is always quite evenly distributed throughout the stone and never found in patches, as is sometimes the case with all other sapphires; therefore the "New Mine Sapphires," when cut and polished, cannot possibly appear particoloured.

SAPPHIRE MINING IN THE DISTRICT OF YOGO, MONTANA, U.S.A.

These gems also, when cut, are seldom "dichroic" in appearance, as the principal axis of the crystal is generally so short that it is almost an impossibility for these sapphires to be cut in any direction except that which gives the true blue colour.

Effective by artificial light. That the "New Mine Sapphires" are effective by artificial light, a charm not possessed by any other sapphires at present upon the market, is possibly one reason why they have so speedily become popular among the fashionable buyers of high class jewels.

Much that I have previously written concerning rubies applies to sapphires also, as they are only another variety of the mineral corundum. Sapphires crystallize in the hexagonal or monometrical system, occurring in hexagonal pyramids and prisms, but, as with rubies, it is comparatively rare to meet with a crystal perfect in shape, as these gems come into the market generally in broken or waterworn fragments, which show upon examination just a characteristic indication of the systems to which they belong. This fact is due to the thousand and one vicissitudes to which gems are subject from the moment of their formation to their appearance at Hatton Garden or some other gem centre as marketable products.

Perfect crystals rare.

Hardness. The hardness of sapphire is 9, and specific gravity 3.90 to 4.16. Sapphire acquires electricity by friction, is doubly refractive to a slight degree, and is also dichroic. The fracture is conchoidal or uneven. The lustre is vitreous, except upon the surface of the crystals, which is generally dull. The chemical composition is practically pure oxide of aluminium.

Although the names by which precious stones are

known in the twentieth century were used by the ancients, in several cases they were applied to absolutely different gems. An instance of this is to be found in the word "sapphire," which was applied

MONTANA SAPPHIRE MINING—A "NEW CUT."

Sapphire of the Romans.

by the Greeks and Romans to the stone known to us as lapis-lazuli, an opaque blue stone with markings of iron pyrites, often erroneously described as gold. There is, however, little doubt that the sapphire was greatly valued and admired in ancient Roman days. It then bore the name of "hyacinthus,"

by which title the honey-coloured varieties of zircon and garnet are now known.

Pliny's description of the hyacinthus proves that he was evidently familiar with the beautiful azure

MONTANA SAPPHIRE MINING—WASHING THE GRAVEL AND DIVIDING IT INTO SIZES.

blue of the sapphire, while Solinus, who lived two centuries later, shows by his poetic and accurate description of the gem that he was in his day a connoisseur of precious stones upon whose judgement we may place reliance, which is certainly more

than we can do with some ancient writers, who often describe a gem in such a way that it is difficult to connect it with any precious stone known to modern science.

The sapphire was dedicated by the Greeks to Apollo, to whom it was thought to be so particularly acceptable, that its presentation ensured a speedy and favourable reply when consulting his oracle. In fact, the ancient name hyacinthus was derived from the resemblance of the colour of the stone to that of the blue fleur-de-lys, which, according to fable, sprang from the blood of Hyacinthus, the favourite of Apollo.

Hyacinthus.

The "Adamas" of Pliny undoubtedly included the sapphire among the different varieties described. The blue variety of corundum was alluded to as "sapphirini" by Camillo Leonardo as early as the end of the fifteenth century (King), and the value of this gem was stated by Cellini to be one-tenth that of the diamond.

Throughout all periods the sapphire has occasionally been selected as material to work upon by glyptic artists, but it is with the greatest difficulty that it is engraved by them on account of its extreme hardness.

Carved sapphires.

In his "Antique Gems," the late Rev. C. W. King, M.A., describes two of the finest productions of the best Greek school of glyptic art upon sapphire. One of these was discovered crudely set in the handle of a Turkish dagger. The design, consisting of a magnificent head of Jupiter in intaglio, was buried face downwards in the setting, and the roughly fashioned back presented the appearance of a stone cut *en cabochon*. Evidently the merit of the

engraver's art was of secondary consideration to the value of the actual material in the opinion of the Oriental into whose possession this beautiful gem had fallen. The other carving was a superb piece of work, although on a pale sapphire unworthy of such a masterpiece of engraving, consisting of the well-known subject of Hebe and the eagle. The subject is engraved in half relief on a stone 1½ inch long by 1¼ inch wide, which is fashioned into the shape of a heart, and drilled through the longest direction evidently at some period previous to the engraving. This gem, probably engraved by a Roman artist of the time of Hadrian, is, perhaps, the finest specimen of ancient glyptic art upon sapphire.

In the collections of cameos and intaglios throughout Europe and America there may occasionally be seen a fine specimen cut upon this valuable material, but they are few and very far between. The finest piece of modern engraving upon sapphire consists of a portrait of Pope Paul III by the famous artist I. L. Greco. The stone, of fine quality and quite square in shape, was used as a signet.

Large sapphires.

Corundum occurs much less rarely in large pieces of fine colour in the form of sapphire than as ruby, but such are nevertheless seldom seen upon the market. In the London Exhibition of 1862 two very fine stones were exhibited. The larger of the two weighed 250 carats, and was oval in shape and of a very dark colour. The other gem weighed 198 carats, and was a much finer stone.

A noteworthy sapphire, weighing 175 carats, was sold in London in 1898. It was a thick stone of oval shape, and of a most pleasing colour and great brilliancy, which was largely due to its extreme depth.

In 1900, also, a fine cushion-shaped sapphire of perfect quality, weighing 47 carats, constituted one of the finest gems seen in recent years. These two last stones I had the responsibility of cutting.

Ancient beliefs.

To the sapphire has always been attributed all kinds of virtues, among which was its power to cure fever and extinguish fire. From the earliest times

LARGE SAPPHIRE SURROUNDED WITH DIAMONDS (ACTUAL SIZE).

it has been considered the emblem of chastity and purity, which was the reason of its adoption from the commencement of the Middle Ages as the gem used in the episcopal ring of office. The oldest ecclesiastical jewel known consists of the ring of the Abbot of Folleville, set with a large native-cut sapphire (Streeter). "The sapphire is said to grow dull if worn by an adulterer or a lascivious person."

CHAPTER XI

THE "ORIENTAL TOPAZ,"—"ORIENTAL AMETHYST,"—"ORIENTAL EMERALD," — FANCY SAPPHIRES, — ASTERIA.

Yellow sapphire.

THE "Oriental topaz," or, as it is perhaps more generally called, the yellow sapphire, is a beautiful limpid gem of exquisite brilliancy, varying in colour from the darkest orange to a delicate primrose yellow.

No stone is more unappreciated and misunderstood than this beautiful gem, for although fine specimens of it are rare, and from a decorative point of view it can compete with many other precious stones which are highly esteemed by wearers of costly jewels, yet there is a great prejudice against it on account of its resemblance in colour to the less costly gem called topaz, and also to the yellow crystal or cairngorm.

But although the same colour may exist in all three of these stones they resemble each other in no other respect. The yellow sapphire, if of fine quality, and properly cut, is so singularly limpid, owing to its great hardness, that it is difficult for anyone to understand why it is not more sought after. The explanation probably lies in the fact that purchasers of costly jewels fear lest the "unobservant observer" may be guided solely by the colour of the

stones, and presume that all yellow stones are cairngorms.

British Museum.

HUGE CRYSTAL OF YELLOW SAPPHIRE (ACTUAL SIZE).

Three stones with the same name. In fact, it is unfortunately the case with many people (even amongst those who constantly handle precious stones) that any yellow stone is at once

dubbed "topaz," as they do not realize that there are three distinct and absolutely different gems sold under this name. They are: (1) "Oriental topaz," or yellow sapphire; (2) topaz; (3) yellow crystal or cairngorm topaz.

Of course, the real cause of the confusion which exists with regard to these stones lies in the very faulty nomenclature of precious stones.

With the exception of that of colour all the physical and optical properties which have been described under the heading of "sapphire" apply to the yellow sapphire or "Oriental topaz," for, as already explained, it is only another variety of transparent crystallized corundum.

Localities. The principal source whence yellow sapphires are derived is Ceylon, where they are found associated with rubies, sapphires, zircons, etc. Very fine yellow sapphires are found in Anakie, Central Queensland, but they are seldom found of large size free from some trace of blue markings, which give to the gems, when cut and polished, a greenish hue. The yellow sapphire was known to the ancients by the name of "Citrinus."

Purple sapphire. *Oriental amethyst.*—The "Oriental amethyst," or purple sapphire, is another variety of the same stone, and is much confused with the purple variety of rock crystal called amethyst, owing to the similarity of the names, in much the same way as the "Oriental topaz," or yellow sapphire is confounded with topaz or cairngorm.

For particulars of the physical and optical properties of this stone, the reader is again referred to the previous paragraph under the heading of sapphire, from which it differs only in the matter of colour.

Parti-colour. The colour of this gem varies from a rich plum down to heliotrope or lilac colour, and many and varied are the different shades and tones of violet which it embraces. Generally, the colour of the purple sapphire is caused by the presence within the stone of patches of blue (sapphire) and red (ruby), which become mingled together by the refraction and reflection of light from facet to facet of the gem when cut, thus producing a purple effect. Sometimes also the colour is distributed in alternate layers of red and blue throughout the stone at right angles to the principal axis of the crystal, giving a striped appearance to the stone in its rough state, and creating a more or less purple colour according to the predominance of the blue or red material.

Change of colour. Many sapphires change from almost the true blue colour by daylight to a decided purple by artificial light. Such gems are of great interest to collectors and connoisseurs of precious stones, but are not popular among jewellers, for it makes a difficult matter to match the shade of colour both by day and artificial light.

An interesting jewel came under my notice quite recently, consisting of a large crescent of sapphires, the gems so arranged that at one end of the ornament they were of a distinct blue, while they gradually shaded off through different shades of purple until they reached a lovely plum colour at the other extreme point of the crescent. The whole of these gems, moreover, changed colour by artificial light and became a rich purple throughout.

Although designed and fashioned purely as an effective jewel, this beautiful ornament could well claim a prominent place in any mineralogical museum

in the world. The stones of which it consisted were derived from Montana, and were found associated with the beautiful "New Mine Sapphires," of which I have already given a description.

Ceylon produces purple sapphires of very fine quality, but as it is not a stone which occurs usually in crystals of large size or in great number, a really fine purple sapphire is rarely met with.

Green sapphire.

Oriental emerald.—The name of yet another gem is, as it were, bracketed with those of the two I have just described, namely:—the "Oriental emerald," or green sapphire.

The colour which is most highly prized in this stone is a bright grass green. Sometimes a green sapphire is formed by the presence in an otherwise yellow stone, of a patch of blue, which mingles with the yellow and creates a green appearance when the stone is cut, or alternate layers of blue and yellow material occur in the same stone, in just the same way as red and blue layers sometimes form the "Oriental amethyst."

Many such parti-coloured green sapphires come to us from Anakie, Central Queensland, and are not so rare by any means as the grass-green stones which owe their origin to Ceylon. The Australian green sapphires are, however, of very great beauty and will undoubtedly prove of great importance in the near future. The physical and optical properties of the "Oriental emerald" are identical with those of sapphire—colour only excepted. This gem must not be confused with the popular gem called emerald.

Sapphires of many shades of colour.

Fancy sapphires.—Under the heading of "fancy sapphires" may be included all those delicate pale shades of corundum gems of different colours which

are of a somewhat nondescript tint. To the pale shades of blue, yellow, purple, green, pink, brown, may be added many which can only be described as bluish-green, greenish-yellow, greenish-blue, greenish-brown, together with dove, mouse, absinth colour, and white.

Sometimes two or more distinct colours occur in different parts of the same stone, thus one end of the crystal of corundum may perhaps be yellow, and the other end blue, one end red and the other end blue. Such stones in the rough state are of great interest to the collector, but it is seldom that both colours are displayed when they are cut and polished, for the effect of light upon the facets of the gem generally cause the colours to become mingled.

The brilliancy of the "fancy sapphire" is very great, and combined with such delicate tones of colour, the effect obtainable with many of these gems is most pleasing, and forms a happy contrast to the glaring and pronounced colours of the ruby and sapphire, to which they are so closely related, in fact, differing only in colour.

Yet "fancy sapphires" rank amongst the less expensive gems, although there is little doubt that if they were suddenly only to be obtained with difficulty, they would soon occupy a more important position in fashionable jewellery.

Coloured sapphires of Montana.

Widely distributed throughout Montana occur pale corundums, which, when cut, form "fancy sapphires" of great beauty. For delicacy of colour and great brilliancy these stones are unrivalled. Ceylon is the great source whence the market is supplied with "fancy sapphires." They are generally crudely cut by the natives before consignment to

Europe, and they have afterwards to be properly re-cut by a skilled lapidary to meet the requirements of the European and American markets.

Asteria, or star-stone.—The asteria or star-stone is probably the most interesting of all gems, and has a fascinating beauty peculiar to itself. It consists of the semi-transparent varieties of corundum cut *en cabochon* in such a direction that the centre of the stone exactly cuts the principal axis of the crystal. From the centre of the stone a six-pointed shimmering star diverges to the edge. The star is white or pale yellow, and in a good light shines with great brightness, forming a brilliant contrast to the other parts of the stone, which remain dull and lustreless. **Star-stones.**

Although star-stones vary in colour to a great extent, the divergent rays reflected on the surface are the same colour in all specimens. When these stones occur red they are called "Star Rubies," and when blue, "Star Sapphires." Under the latter title also are included many pale shades of gray, bluish-white, yellowish-white, purple, etc., which are interesting and beautiful, but more readily obtained than the red and blue varieties.

An explanation of the glittering star upon the surface of the star-stone is to be found in the structure of the crystal, which is of a peculiarly laminated texture, presenting upon sections cut at right angles to the principal axis of the crystal, striations and markings parallel to the faces of the prism. These markings consist of innumerable minute cavities, and they form three lines which cross one another in the centre at an angle of sixty degrees, giving rise to the chatoyant star. A twelve-rayed star is occasionally formed by the presence of an additional set of **Cause of star.**

lines. Sometimes a star-stone is found containing a small quantity of water enclosed within it.

Star-stones are found in conjunction with sapphires and rubies in Burma, Kashmir, and Ceylon. The star-stone was known to the ancients by the name of Asteria, and there are references in the writings of Pliny to show that he associated the name with the same gem which we call star-stone to-day.

CHAPTER XII

SPINEL

THIS stone occurs in a range of colours equal in variety and number to those of the corundum gems. Many varieties of spinel bear a great resemblance in colour to other totally different kinds of gems, such as the ruby, sapphire, garnet, tourmaline, etc. There are, however, a large number of very beautiful colours, particularly the pale delicate shades, which cannot be compared with any other gem stone, while the scarlet variety possesses a vivid flame-like appearance which is unique among precious stones.

CRYSTAL OF SPINEL (ACTUAL SIZE).

Flame-red spinel.

The red and blue spinels are sometimes called respectively "*balais* or spinel ruby," and "spinel sapphire," but such names are not only inartistic and unscientific, but decidedly misleading. Distinguishing names have also been applied to other varieties of spinel, viz., orange red, "rubicelle"; green, "chlorspinel"; violet, "almandine spinel"; and black, "pleonaste"; but with the exception of the red variety known as spinel ruby, the gem is usually spoken of as spinel, with a prefix descriptive of the colour.

The spinel does not possess the property of refracting and dispersing the light to a great degree, consequently the brilliancy of the gem is not to be compared with that of the ruby, sapphire, etc. Nevertheless, owing to the beauty and variety of the colours in which this gem occurs, it is one of the most decorative of precious stones. Spinels suitable for jewellery are transparent, but the mineral also occurs opaque. Those of a dark colour have a tendency to appear blackish when cut and polished, and it therefore often happens that a stone of a beautiful rich colour in the rough state, will result in a disappointing gem when cut, even if manipulated by skilful hands.

Systems. The spinel crystallizes in the cubic system, generally occurring in octahedra or twin crystals, which are frequently very perfectly formed, and the faces of which are smooth and often highly polished. It is singly refractive, nondichroic; lustre, vitreous; hardness, 8; specific gravity, 3.5-3.6. The chemical composition is alumina and magnesia in the proportion respectively of about 71.99 and 28.01, but a portion of the magnesia is often replaced by protoxides of zinc, manganese and iron, and the alumina sometimes by protoxide of iron.

Localities. The finest spinels are found in India, Ceylon, and Brazil, but are also mined in Siam, Burma, Afghanistan, New Jersey, and New York, generally embedded in granular limestone, gneiss, or volcanic rocks.

The spinel was by the ancients confused with the gems which it resembles, from which they had no means of distinguishing it, and until comparatively recently, it was not properly understood. The *balais*

ruby or red spinel was the favourite precious stone of Queen Elizabeth of England, and mention is made of several splendid jewels containing the stone in an inventory of her personal ornaments still in existence among the papers of the State.

The gem known as the "Black Prince's Ruby," which forms one of the Crown jewels of Great Britain, is stated to be a red spinel. **"Black Prince's Ruby."**

With the exception of the flame-red and a few other rare-coloured varieties, the spinel is a gem which does not command a high price, but it is appreciated by all lovers of precious stones on account of its large range of colours and the beautiful effects which can be obtained with it.

CHAPTER XIII

BERYL—EMERALD—AQUAMARINE—EUCLASE

Colour chief difference.

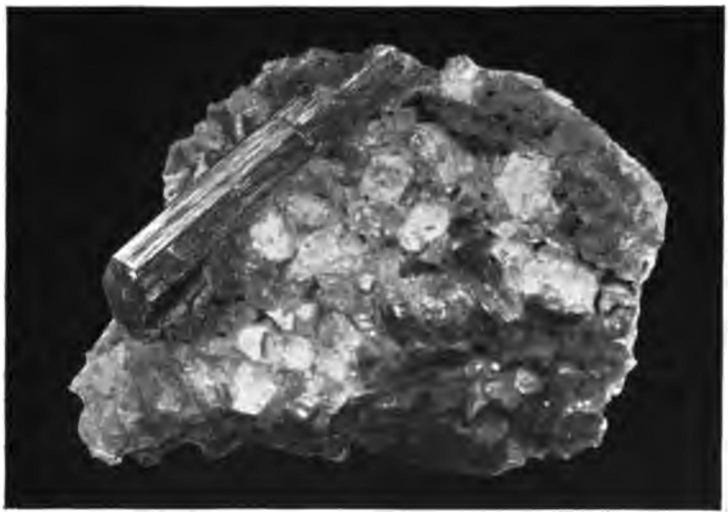
IN chemical composition the emerald, aquamarine, and beryl are practically identical; in fact, the first two mentioned are varieties of the mineral beryl. The chief difference between these gems, and one which is of enormous importance to the jeweller and wearer of precious stones, is that of colour.

The emerald, which is at the present time the most precious of gems, is a bright green gem, of which the colour can only be described as "emerald green," for the stone has given its name to the colour which is so familiar to all.

The aquamarine is pale blue or sea-green, and although a gem of small commercial value compared with the emerald, constitutes an effective stone, fine specimens being in considerable demand.

Under the name of beryl are known the varieties of the mineral which occur sage-green, yellow, and white, and, in extremely rare specimens, rose pink. Beryls are very beautiful stones when of fine quality, but are, together with many other gem stones, greatly misunderstood and unappreciated. All the varieties of the mineral possess a wonderful degree of limpidity, and consequently, when skilfully cut, form stones of great brilliancy.

The mineral beryl crystallizes in the hexagonal system, and is generally found in six-sided prisms. Sometimes the crystals are striated both internally and externally, parallel to the principal axis of the crystal, frequently to such an extent that the crystal has somewhat the appearance of a corrugated **System.**



British Museum.

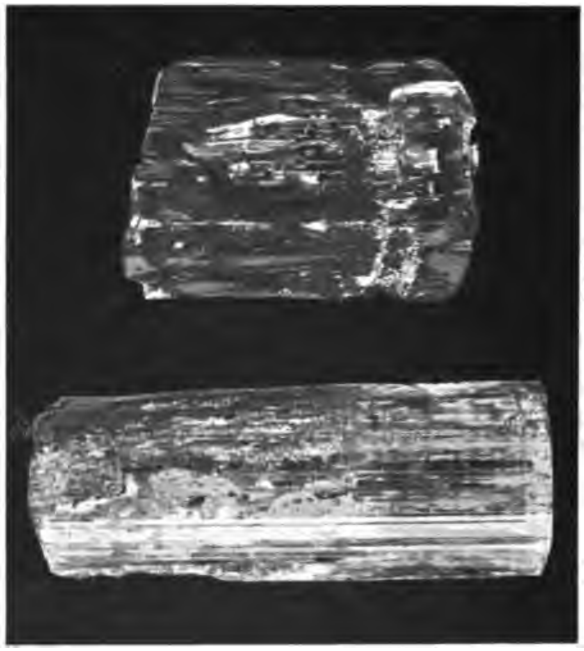
CRYSTAL OF BERYL ON TOPAZ.

cylinder. These striae are, however, not developed on crystals of the variety emerald, nor do the crystals of this variety assume such large dimensions as the other varieties of beryl. Crystals of beryl are often "eaten away" as if by acid, especially at the ends of the crystal, in a most unaccountable way. The indentations thus formed sometimes extend to the depth of nearly half an inch. Although the stones

are in this condition when first found, I believe the cause of the alteration has still to be discovered, for we know of no acid which will attack the material in the same way.

Flaws and feathers.

The emerald is subject to minute feathers, flaws,



British Museum.

CRYSTALS OF BERYL (ACTUAL SIZE).

and other imperfections from which the aquamarine and beryl are generally fairly free. In fact, it is so rare to find an emerald without some such blemish that "like an emerald without a flaw" has become quite a proverbial expression to describe anything unusually perfect.

The different varieties of beryl vary to some slight extent in hardness, from 7.5 to 8, emerald being slightly softer than the other varieties. The emerald is very brittle, and many magnificent specimens of this gem have been from time to time utterly ruined by rough usage of ignorant people.

Large crystals. Crystals of opaque beryl, which are, in consequence of their opacity, unfit for use in jewellery, have been found of enormous size. One is said to have been found (Kunz) in Royalston in Massachusetts, which measured 45 inches in diameter and over a foot in length, and weighed nearly 2½ tons. Even transparent aquamarines and beryls, suitable for cutting up into gem stones, are sometimes found from four to six inches long, by one and a half to three inches in diameter. Of course, the gems cut from such stones are not nearly so large as the rough stone, for a very large percentage of the raw material is found to be worthless, and has to be removed in order to retain those parts suitable for cutting and polishing into gem stones. The crystals of the variety emerald, as before stated, do not assume nearly such large dimensions.

The cleavage of beryl and its varieties is parallel to the basal plane—indistinct. Fracture, conchoidal or uneven. Lustre, vitreous. The refraction, double. The emerald shows twin colours—greenish blue and bluish green; the aquamarine, straw and grayish blue, or yellowish blue and gray; and the other varieties of beryl equally distinct effects when examined with the dichroiscope. The specific gravity is 2.75. The composition is silica, 68.0; alumina, 18.3; glucina, 12.2; magnesia, 0.8; soda, 0.7.

The colour of emerald is due to traces of a minute

quantity of oxide of chromium, and other varieties of beryl doubtless owe their colour to the presence of equally minute traces of other oxides.

"Old Spanish" emeralds.

Emeralds of fine quality are alluded to as "fine old Spanish emeralds" by connoisseurs of precious stones throughout the world, yet there never was an emerald mined in Spain. The reason for this is not generally known, and is somewhat interesting.

The emerald was comparatively rarely seen in

FACETTED EMERALD (ACTUAL SIZE).

LARGE ROUGH EMERALD (FRAGMENTARY).

modern Europe until the conquest of Peru by the Spaniards, when immense quantities of booty in the form of precious stones and gold were brought from that country to Spain. Emeralds formed an important part of this loot, for the Peruvians had accumulated great numbers of beautiful stones, to which they attached little value beyond using them as ornaments and to adorn their temples. Thus the finest emeralds came into the possession of the old families of Spain, and long afterwards this country

was famous for her emeralds, and the expression, "Spanish Emerald," remains with us to-day.

Probably the gem known to us in the twentieth century under the name of emerald was greatly admired and valued by the ancients, and from the most remote times has occupied an important position among the jewels both of civilized and barbarous races. Just as the ancients, however, confused rubies, garnets, and other red stones, so they appear to have applied the name "Smaragdus" to almost all green stones, including emerald, chrysoprase, jasper, plasma, fluor, etc.

Smaragdus.

From the ruins of bygone civilizations, jewels are occasionally brought to light in which are set either rough fragmentary crystals, or beads and charms of emerald, some of which are often elaborately carved and fashioned.

By the ancient Greeks and Romans the emerald was supposed to cure weak and sore eyes simply by the sufferer gazing at it, and gem engravers rested their eyes from time to time during their work by fixing their eyes upon this gem.

Nero is said to have used an emerald as an eye-glass, with which to watch the gladiators combating in the arena.

Emeralds of Egypt.

The ancients derived their emeralds from a series of mines at Coptos in Egypt, and to this day traces of the original workings can easily be seen. The name of "Cleopatra's mine" has been used in connection with certain of these old mines. The workings consist of small passages burrowed in the micaceous schists, in which material the emeralds are found. These passages are of some considerable length, and lead to subterranean chambers where

the tools, etc., used by the ancient miners, remain to this day.

Not only can the excavations originally made still be traced, but huge barrack-like buildings, large enough to accommodate at least 2,000 persons, and probably used by armies of slaves at work in the mines, still remain intact. There also still remain the original watch towers, and from the mines, it has been discovered that there exists, almost obliterated with the desert sand, a paved roadway or terrace reaching to the banks of the Red Sea, where are still to be seen the wharves used by the miners 2,000 years ago.

There are distinct indications of several successive races having worked upon these mines, each, for some cause or other, having eventually abandoned them.

Emeralds of a rich green colour were also mined anciently in Ethiopia, a distance of three days' journey from Coptos. These stones were, however, evidently lacking in brilliancy, and the colour was frequently unevenly distributed throughout the stone. The question of to-day is, are the Egyptian mines worked out, or, judging from the poor quality of the few emeralds still to be found in these mines, is one to conjecture that gems which to-day would be of little or no value were highly esteemed by the Greek jewellers, or, again, is there some Eldorado still to be discovered in the form of a rich emerald mine which has hitherto escaped the notice of explorers?

Columbian emeralds.

The principal supply of emeralds at the present day comes from South America, the Republic of Colombia and Peru being the chief sources. New South Wales, Siberia, Hindostan, Norway, and North Carolina, U.S.A., also produce these stones,

but hitherto in an unmarketable quality. The beryls found in Siberia and in many localities in the United States are, however, of considerable importance, and it is considered not unlikely that the emerald variety of this mineral may yet be discovered of fine quality associated with them.

The most famous emerald mines are those of Muzo and Coscuez in the Columbian Republic, which were discovered in the middle of the sixteenth century, and have produced practically all the fine emeralds mined since that time. The mines lie about four miles to the West of the town of Muzo in the Eastern Cordillera of the Andes and about seventy-five miles north-east of Santa Fé de Bogotá. The emeralds are found in lime stone and slate, and occur either as single crystals or lodes.

CRYSTAL OF EMERALD IN MATRIX (ACTUAL SIZE).

These mines, which are the property of the Government, are usually let on lease for terms of years to the highest bidder, who also has to pay a large sum (about £40,000) as premium upon taking up the tenancy. **Muzo mines.**

Many fine emeralds have been cruelly sacrificed by being hollowed out, carved, or drilled by the native races of Asia, as mentioned in my chapter on cutting precious stones. As a very good example of

this, the following description of an emerald which was formerly in the famous Hope collection will be of interest. It is copied from the original catalogue of the collection which was compiled by Herz in 1839.

Emeralds of interest.

"A large emerald of an oval form and fine green tint (the true emerald colour) cut *en cabochon*, with brilliant facets round the bezil; at the back it is

CRYSTAL OF EMERALD IN MATRIX.

hollowed out like a shell garnet. It will perhaps be necessary to explain here the reason why this gem is cut in a manner so unbecoming in an emerald, which has taken away a great deal of its precious substance, and diminished it in weight as well as in value; but it was the fancy of some Eastern prince to make this emerald the frame of a beautiful Oriental topaz; the latter stone was fixed in the hollow part of the emerald with some mastic or cement, which

gave both stones a dull appearance, and the Oriental topaz was set round with some small brilliants; it would be difficult to conjecture why these two gems should have been so strangely united so much to their mutual disadvantage. This emerald, though not free from flaws, is of a pleasing hue, and, according to a technical term in use among jewellers, of a fine velvet."

Another interesting emerald which was formerly in the Hope collection is: "A most extraordinary stone of an oval shape, cut *en cabochon*, of a light green colour and nearly opaque, which is occasioned by a silky substance in the interior which produces a chatoyant lustre as fine as is seen in any cat's-eye; this is an accident rarely met with in the emerald, wherefore this curious specimen was well worthy of its place in this rare collection."

Curious formation.

In the Townshend collection of gems exhibited at the South Kensington Museum there is "A curious emerald of a circular form and deep green colour; cut flat at the top, with a slanting edge, and convex at the back; it presents in its interior a fixed six-rayed star, which is seldom met with in an emerald." Although not possessing any very great decorative quality this stone is of remarkable interest.

In the Hope collection were many very fine beryls and aquamarines, some of which are now to be seen at the South Kensington Museum, and others are in private hands. The following are descriptions of several of the most important which have been taken from the catalogue already referred to.

Famous beryls.

"A superlatively fine aquamarine, of an oval shape and of the finest sea-green colour, most admirably cut, with seven rows of brilliant facets in front, and

steps at the back; this fine gem is of the purest fine deep green tint, free from any flaw or defect, and displays the highest degree of effulgence; its extraordinary size and charming hue, combined with its

LARGE FACETTED AQUAMARINE.

great perfection, entitle it to the denomination of matchless." Weight, 5 oz. 17 dwt. 12 gr.

"A most exquisite oval-shaped aquamarine, cut by the most skilful hand in the same manner as the two former specimens; it is of a beautiful deep blue tint approaching the sapphire colour; there is, however, a slight mixture of green with the blue, con-

stituting at once the character of the aquamarine. This superb gem is of the greatest purity and perfection, as well as of a very captivating hue; it scarcely yields in brilliancy to any other precious gem; it may well be termed unique, and is fit to adorn the crown of a monarch." Weight, 1 oz. 17 dwt. 15 gr. This gem is now in the Townshend collection.

"A superlatively fine and large aquamarine, from Siberia, of a fine golden sherry colour, and of an octagonal form, beautifully cut with step facets in front and at the back; notwithstanding a few trifling flaws, which are scarcely perceptible, this gem is of the utmost brilliancy and of a charming hue; on account of its extraordinarily curious colour it may be called unique."

"A matchless aquamarine, in the form of a sword handle, cut all round with long facets which cross each other obliquely; it is of the most beautiful sea-green colour, and of the utmost perfection. This gem belonged to Murat, and was mounted in his sword; it has been re-mounted in fine gold, ornamented with brilliants, turquoise, and garnets, and a most beautiful carbuncle on the top; it is four inches long, and weighs 3 oz. 6 dwt."

Engraved emeralds.

All the varieties of beryl, including the emerald, have been used as a material for the glyptic art, and there are many cameos and intaglios of the Renaissance period to be seen in collections of works of art. Among carved gems of antiquity most of the beryls are found to be of Grecian origin, while the emeralds belong to the Roman period.

In the Hope collection was a very curious antique engraved emerald, of a fine green colour, in the form

of an owl with a human face, most probably of Egyptian origin.

The beryl was the only gem which was cut with facets by the Romans, who smoothed and polished the natural hexagonal prisms in which the stones were found, in order to increase the lustre. They were also fashioned into eardrops and beads in the shape of a cylinder, which were drilled and strung upon elephant's hair. Others were not bored, but were gripped at either end by a boss of gold or other metal.

At the time of the Renaissance, Cellini states, an emerald was worth four times as much as a fine diamond of the same weight, and half as much as a ruby. The aquamarine was greatly esteemed until the end of the eighteenth century, when large quantities were placed upon the market, and the value of this gem subsequently diminished. Emeralds are in very great demand at the present time, and fetch prices hitherto unheard of, and fine aquamarines and beryls are very much in vogue.

EUCLASE

Useless as a jewel.

The euclase is a transparent mineral which is allied to the emerald from a chemist's point of view, and also when cut and polished it somewhat resembles inferior specimens of that gem. It is, however, quite unsuitable for the purpose of jewellery, for, as its name implies, it is so extremely brittle, owing to its perfect cleavage, that it not only is cut and polished with great difficulty, but cannot withstand the constant friction to which a jewel is subject.

The colour of the mineral varies from green-white to green, and rarely to slaty blue. It occurs in the monoclinic system, and generally assumes the form of the oblique rhombic prism. It is doubly refractive and exhibits the phenomenon of trichroism. Colour.

EUCLASE (FRAGMENTARY).

Lustre, vitreous; hardness, 7.5; specific gravity, 2.9-3.2.

It is found near Villa Rica, Paraguay, accompanied with topaz; also in Peru and the Ural Mountains on the Sanarka River. The chemical composition of euclase is: silica, 43.2; alumina, 33.6; glucina, 23.2.

CHAPTER XIV

CHRYSOBERYL—CYMOPHANE OR CAT'S-EYE—ALEXANDRITE—PHENAKITE—ZIRCON—JACINTH

THE chrysoberyl is a beautiful transparent gem stone occurring in different shades of green, yellow, and brown. The green and brown specimens are generally of a subdued tone, and form a delicate contrast to gems of more pronounced hue. The green, although varying in shade, are nearly all of the colour known as sage green, and never present a vivid hue; occasionally, however, a chrysoberyl resembles the colour of a pale green aquamarine. The yellow stones are not unlike yellow sapphires, but occur generally in the more delicate colours, while the brown chrysoberyls approach to a mahogany colour. The name of the stone is derived from the Greek "chrusous," golden, and "beryllus," beryl.

Effective gems.

The chrysoberyl when properly cut is a brilliant and effective gem. The system in which the gem occurs is the trimetric, and the crystals generally assume a tabular form. It is dichroic, and many specimens possess this property in a very marked degree. As with all highly dichroic gem stones, a variety of effects can be produced by the lapidary by cutting this stone at various angles of the original crystal.

The hardness of the gem is 8.5, and therefore is

almost as great as the sapphire. Specific gravity, 3.5-3.7. The chemical composition is: alumina, 80.2; glucina, 19.8.

Ceylon is the principal source of the chrysoberyl, but it is also found in the Urals, Brazil, and in the United States, at Haddam in Connecticut, and Saratoga, New York, accompanied with garnet and beryl.

Cymophane or *Cat's-eye.* A variety of chrysoberyl forms the popular and beautiful gem known as cymophane or cat's-eye. This gem, which is always cut *en cabochon,* displays a bright, silvery, shimmering line across the summit, and when accurately cut, directly down the centre of the gem.

This gem occurs in all the shades of colour in which chrysoberyls are found, but the line or ray is much paler and generally almost white. The whiter and narrower the ray the greater is the value of the stone. The colour of the gem, which is most highly prized, is described as "gooseberry green," while honey colour and citron yellow are much esteemed.

The ray is caused by a peculiar striated structure of the stone, which develops the steely reflection across the gem.

Change of fashion.

Cat's-eyes were formerly in great demand, but of recent years they have, by one of fashion's fatal decrees, been banished from the position they once held, though they still stand in the first rank of precious stones.

The chrysoberyl cat's-eye is somewhat resembled by an almost valueless variety of quartz, which possesses a bright line down the centre when cut *en cabochon.* This stone is known as quartz cat's-eye, and is pretty enough in a way, but it does not pos-

sess either the delicate colouring or the great brilliancy of the chrysoberyl or true cat's-eye. Even the uninitiated can easily distinguish between the two stones by the unaided eye, or by taking the specific gravity they are at once differentiated.

The cymophane is derived almost exclusively from Ceylon. The Cingalese are said to believe

British Museum.

CRYSTALS OF ALEXANDRITE (ACTUAL SIZE).

that cat's-eyes are embodied spirits, and they certainly have from the earliest ages been surrounded with mystery and looked upon with suspicion in the East.

Changes colour.

Alexandrite. Another variety of chrysoberyl which constitutes a most fascinating gem is that known as alexandrite. This gem possesses the peculiar phenomenon of changing colour; by daylight a fine quality alexandrite appears a rich pistachio

green, while it changes to raspberry red in artificial light. The colour is said to be due to the presence of chrome, otherwise the chemical composition is the same as chrysoberyl. A fine example of this beautiful stone is a great rarity, and is a gem of considerable value.

Inferior specimens do not display such a pronounced alteration in colour, changing, say, from a brownish green to a reddish brown, or else possessing the desired appearance only by day or artificial light, and such stones are fairly plentiful. Sometimes this variety of chrysoberyl will possess the shimmering ray characteristic of the cat's-eye, when it is known as "alexandrite cat's-eye"; such gems are extremely rare and very highly valued by connoisseurs of precious stones.

Alexandrite cat's-eye.

The alexandrite was first discovered in the Urals, and was named after Alexander II, Czar of Russia. The finest alexandrites are derived from Takowayo in the Urals, but are of rare occurrence. The chief source of the supply of this gem at the present time is Ceylon.

Phenakite

Seldom used in jewellery.

The transparent variety of the mineral phenakite, although very rarely used by the jeweller, forms a most brilliant gem when properly cut. It is seldom seen, however, out of a collection. It is either white or slightly tinged with yellow. The hardness is 8; specific gravity, 2.97. Phenakite occurs in the hexagonal system, obtuse rhombohedron being the form in which it generally occurs.

The chemical composition of this gem stone is: silica, 55.43; glucina, 44.48, with traces of magnesia

and peroxide of iron. It is doubly refractive, and the coloured specimens, when examined by means of

CRYSTAL OF PHENAKITE IN THE MATRIX (ACTUAL SIZE).

British Museum.

CUT PHENAKITE (ACTUAL SIZE).

the dichroiscope, show one image colourless and the other brownish yellow.

The origin of the name of this mineral is a Greek word meaning "deceiver," which has doubtless been applied from the resemblance of the stone in the rough state to quartz.

Fine specimens of phenakite are found in Ekaterinburg, in the Ural Mountains, associated with emeralds, and at Framont in the Vosges. This mineral is also found at Mount Antero in Colorado.

Zircon or Jargoon—Jacinth

That the zircon or jargoon is one of the most unappreciated of gem stones is undeniable, yet the reason why such should be the case is hard to seek. Not only does this gem possess a range of colours of great beauty, but it also possesses the property of dispersing and refracting the light to a degree only excelled by the diamond itself.

Next to diamonds in brilliancy.

CRYSTAL OF JARGOON OR ZIRCON (ACTUAL SIZE).

With the exception of a vivid orange and an angelica green, most of the colours in which the jargoon occurs can best be described as autumn tints, for they consist of innumerable shades of sage green, columbine red, russet brown, and occasionally giraffe brown verging into gamboge yellow. There is also a white variety, but this is of rare occurrence. The colour of some zircons can be reduced or re-

moved by application of moderate heat, and it is said that stones treated in this way have been passed off for diamonds.

System. The jargoon or zircon crystallizes in the tetragonal system generally occurring in the form of a tetragonal prism combined with a tetragonal pyramid. It is also frequently found in granular fragments. The cleavage is indistinct, lustre adamantine,

CRYSTAL OF ZIRCON IN MATRIX (ACTUAL SIZE).

fracture conchoidal, doubly refractive, and dichroic. Hardness, 7.5; specific gravity, 4.6. Transparent to opaque, but only the former variety is suitable for jewellery. Chemical composition: silica, 33.77; zirconia, 66.23.

A remarkable feature in connection with the jargoon is the very great variation in hardness in different specimens of the mineral.

This peculiarity is strikingly noticeable to a lapidary, for some stones are found to cut and polish with

the utmost ease, while others drag and tear the wheel in such a way that the process is one of great difficulty.

Peculiarity of hardness.

So great is the difference in hardness referred to, that it would seem that there are two or more varieties of the mineral which have not yet been diagnosed and classified.

It is noteworthy that the difficulty has been met by the working lapidary, who roughly discriminates

CRYSTAL OF ZIRCON OR JARGOON IN MATRIX.

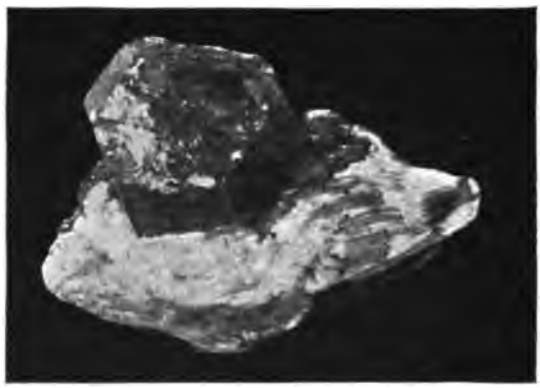
between the apparently different varieties by calling the hard ones zircon and the soft ones jargoon. The subject of the great variation in hardness of the jargoon was first mooted by me in the "Mining Journal," dated January 29th, 1903.

Absorption bands.

When carefully examined with the spectroscope, some specimens of zircon display a characteristic effect, discovered by Professor A. H. Church. Certain black absorption bands are seen across the spectrum, which place the identity of the gem beyond doubt.

Ceylon produces zircons of very fine quality, and most of these stones upon the market are derived therefrom. Many beautiful specimens have also been found in Queensland, some possessing the wonderful brilliancy to which I have alluded in a very marked degree, although, in regard to colour, there seems to be a great sameness in the zircons from this locality.

Together with many other kinds of gems, large



FRAGMENTARY CRYSTAL OF ZIRCON.

quantities of zircons are consigned to Europe and America from Ceylon, in the "native cut" state. As the real beauty of the gem depends upon the skilful handling of the lapidary, it is necessary for them to be accurately re-cut, in order to display the greatest amount of brilliancy which the material can produce.

The name "zircon" is derived from the Arabic word "zerk" meaning "a precious stone."

Jacinth. *Jacinth.*—It is to the brownish honey-coloured

variety of jargoon that the name "jacinth" properly belongs, but the variety of garnet known as "essonite," which somewhat resembles it in colour, is almost universally included in the term.

Most probably the modern jacinth is the stone described by Theophrastus, and known to the ancients by the name of lyncurium.

CHAPTER XV

TOURMALINE

ONE of the most remarkable gem-stones is undoubtedly the tourmaline. This gem occurs in many different colours and possesses in a most marked degree the property of dichroism, or, in other words, it appears a different colour when viewed in different directions. This property is exhibited by all coloured, doubly-refractive, transparent gems, but tourmaline displays the phenomenon to a much greater extent than all others. A crystal of tourmaline, when viewed across the crystal, may appear, say, sage green, while if viewed along the length of the crystal it may appear black or almost black; or a stone appearing rich orange colour across the crystal may appear very dark brown if viewed down the length of the crystal. The degree with which the property of dichroism is displayed varies very considerably in different specimens, as in some the darker colour is so dense that it renders the stones unsuitable for cutting into gems, while in others the two colours cause a pleasing effect if the stones be properly cut.

Highly dichroic.

Tourmalines of pale colour exhibit the phenomenon in a much less degree than the darker varieties of the gem stone.

Methods of cutting.

If a tourmaline be cut with the table of the gem at right angles to the length of the crystal it will

appear only one colour, which, if the dichroism of the stone be very pronounced, may possibly be

British Museum.

ROUGH RED TOURMALINE (ACTUAL SIZE).

black or almost so, while upon looking through the edge of the gem sideways it will appear quite a different and probably a much paler colour. On the

other hand, if the stone be cut with the table of the gem parallel to the length of the crystal, both colours are produced in patches, two of which may be black, or at all events much darker than the other two, according to the degree of dichroism of the stone. In the latter case the effect is very pleasing unless there are black patches, and even then, in the case of a gem of some considerable length, the effect is good,

SECTIONS OF PARTI-COLOURED TOURMALINES CUT AT RIGHT ANGLES TO LENGTH OF CRYSTALS.

for the black patches will appear only at the ends of the gem, while the rest of the stone is a paler colour. A gem cut in the latter way will appear dark or black if viewed through the edge in one direction from one side of the stone to the other. In some of the paler varieties of tourmaline the property of dichroism is of less importance, as the gems are effective when cut in either direction.

Tourmaline occurs in the following colours: red, pink, yellow, brown, green, blue, black, and very

rarely white. The last two mentioned are, however, unsuitable for use in jewellery.

The red and pink variety is sometimes called "rubellite"; the green, "Brazilian emerald"; the yellow, "Ceylon peridot"; the blue, "indicolite"; the black, "schorl"; and the white, "achroite." Several of these names are, however, misleading and unnecessary.

Parti-colour.

It is not unusual for tourmalines to be parti-coloured, pink and green, or pink and blue, which appearance often takes the form of a crust of one colour containing a core of another colour. Thus a section of such a crystal of tourmaline cut at right angles to the length of the crystal may be a pink surrounded by green, or *vice-versâ*. Also some crystals of tourmaline are red at one end, and green, blue, or black at the other. When these parti-coloured tourmalines are sufficiently free from imperfections to cut into gem stones, they are certainly decorative and effective, for two or more colours are seen in the same stone.

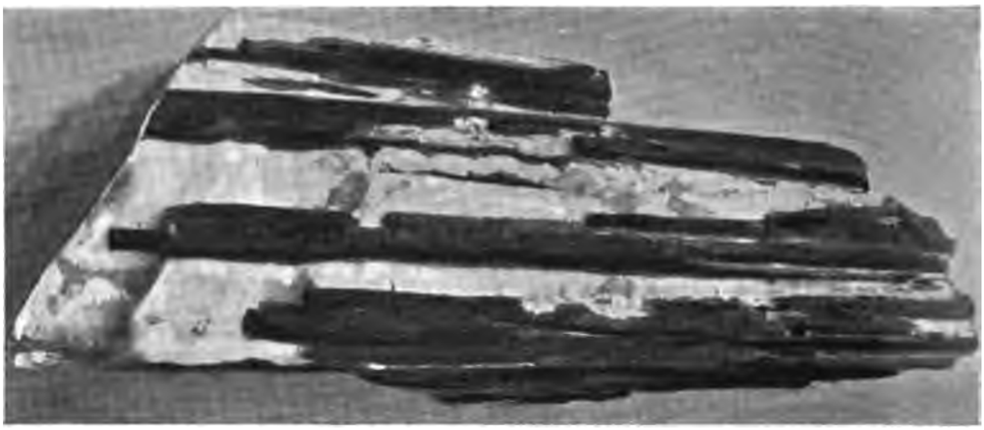
Minute feathers.

The tourmaline is not subject to the imperfection of spots and lines of semi-opacity or milkiness, which mars the beauty of many other kinds of precious stones, but some specimens, especially the pink ones, are full of minute feathers, which greatly detract from the brilliancy.

This gem-stone occurs in the hexagonal system and generally assumes the form of the hexagonal or triangular prism, the opposite terminations of which are usually dissimilar. The crystals are generally grooved or channelled longitudinally. It is doubly refractive and dichroic; lustre, vitreous; fracture, uneven to sub-conchoidal; hardness, 7-7.5, but rather

brittle; specific gravity, 2.9-3.3; becomes electric by heat, one end of the crystal exhibiting positive and the other end negative electricity.

The composition of tourmaline is very variable and very complex; the silica only may be said to be of practically the same proportion in all specimens. The different colours are due to the variation of the



CRYSTALS OF DARK GREEN TOURMALINES IN THE MATRIX (ACTUAL SIZE).

composition. The following analysis by Rammelsberg of a brown specimen from Brazil is given by most writers upon the subject, as being a suitable example:

Silica	38.85	Lime	1.60
Alumina	31.32	Soda	1.28
Boracic Acid . .	8.25	Potash	0.26
Peroxide of Iron .	1.27	Fluorine	2.28
Magnesia	14.89		

Localities. The finest tourmalines are derived from Brazil,

Ceylon, Ava, Siberia, Kangaroo Island, California, and several other localities in the United States of America; they also occur in Europe, but of unmarketable quality. This gem-stone usually occurs in granite, gneiss, granular limestone, dolomite, mica-slate, or chlorite-slate.

The name tourmaline is derived from the Cingalese, Turamali.

The red and pink variety of tourmaline is the most highly valued for jewellery, but the blue is very rarely found, while the green and brown occur most frequently. This gem is also used in the manufacture of certain scientific instruments.

It is noteworthy that the pink tourmalines from North America have a decided tendency to turn a brownish shade by artificial light.

CHAPTER XVI

SPODUMENE—HIDDENITE—KUNZITE—TOPAZ

SPODUMENE is a mineral which generally occurs in dull grayish-green or greenish-white crystals, which are nearly always almost opaque. Sometimes, however, they are a delicate primrose yellow, and also transparent. Although with considerable difficulty, owing to the mineral possessing a very perfect cleavage, such specimens may be cut and polished into brilliant and pleasing gem stones.

Difficult to cut.

Spodumene crystallizes in the monoclinic system; it also occurs massive, with a lamellar structure. It varies from transparent to opaque in different specimens. Lustre vitreous, but nearly on cleavage planes; hardness, 6-6.5, but very brittle; doubly refractive; specific gravity, 3.1. Composition (Hagen): silica, 66.14; alumina, 27.02; peroxide of iron, 0.32; lithia, 3.84; soda, 2.68. Obtainable in Massachusetts and several other places in the United States, and in Brazil.

Hiddenite.

Hiddenite.—The mineral spodumene is also found in bright green transparent crystals, which, when cut, form most effective gem stones, somewhat resembling green garnets. It is generally found in very small fragments.

This variety of spodumene is called hiddenite,

after Mr. W. E. Hidden, who first discovered it, but is also known as "lithia emerald." It is at present only obtainable from Alexander County, North Carolina, but in small quantities.

Both the yellow spodumene and hiddenite are rarely used in jewellery in Europe, although in the United States they were at one time in demand, owing to the interest attached to them as being produced in North America; they are, however, to be seen in collections of precious stones. One of the finest known specimens of hiddenite is now in the Mineralogical Department of the British Museum at South Kensington. Sometimes crystals of spodumene are primrose yellow at one end and bright green at the other.

FRAGMENTS OF SPODUMENE.

Only recently discovered.

Kunzite.—Recently another variety of the mineral spodumene has been discovered at Pala in San Diego County, California. It is of a delicate lilac colour, greatly resembling that of pale amethyst. A graceful compliment has been paid to Dr. George Kunz, President of the New York Mineralogical Club, by the professors who made an exhaustive examination of the gem, and unanimously agreed to call the new discovery "kunzite."

Kunzite, in addition to being an attractive gem-

stone with regard to colour and lustre, possesses the peculiar property of fluorescence. Professor Baskerville, of the University of North Carolina, who has been greatly interested in the new gem, states that "after being exposed to ordinary sunlight the power of fluorescence is apparent, and that also upon exposure to the Röntgen rays for a period of five minutes, a piece of kunzite will absorb sufficient radiance to photograph itself upon a piece of sensitive paper if left in a dark room, remaining slightly self-luminous for some minutes." Exposure to radium has a similar effect upon this variety of the mineral.

Topaz

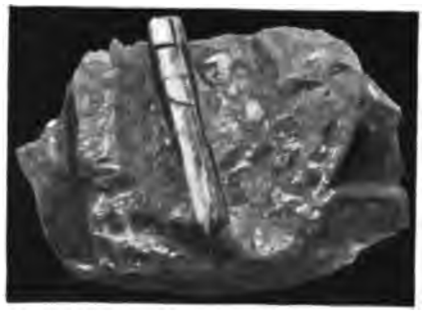
The name topazius was applied by the ancients to the gems known to-day as peridot and chrysolite, and the gem we now call topaz (to which the name was subsequently applied), was only comparatively recently recognized as a distinct mineral.

Brazilian or true topaz.

At the present day some confusion exists with regard to the name of this gem, for in addition to the true topaz, sometimes called "Brazilian topaz," there are the yellow variety of sapphire, sometimes called "Oriental topaz," a most lustrous gem of considerable value, and the yellow and brown quartz, known as "Scotch," or "cairngorm topaz," which is obtainable in large quantities, and of little value.

The true topaz, however, resembles these stones only in colour, and can be easily distinguished by the difference of the hardness and specific gravity, while to the experienced eye the three stones present a very different appearance, even in cut and polished specimens.

The topaz is a transparent gem crystallizing in the rhombic system, generally occurring in right rhombic prisms. The crystals are seldom doubly terminated. The prism faces are usually grooved parallel to the length of prism. It is doubly refractive and dichroic. The cleavage is highly perfect at right angles to the principal axis. Fracture, uneven to sub-conchoidal; lustre, vitreous; hardness, 8; specific gravity, 3.4-3.6; chemical composition: silica, 33.3; alumina, 51.7; fluorine, 15.0.



CRYSTAL OF PINK TOPAZ IN MATRIX (ACTUAL SIZE).

The topaz occurs in many different shades of yellow and brown, also greenish white, blue, and rarely pink and pale red. Some of the dark yellow and brown specimens can also be altered to a delicate pink by careful application of heat. This is a somewhat difficult operation to perform, as it is necessary to guard against any sudden alteration in temperature, or the stone will be found to be flawed, or if the heat be too great, it will be found to be colourless. The power of changing the colour of the topaz by application of heat was first discovered by accident in 1755 by an old French jeweller, named Dumelle. His method of effecting the change was to heat the yellow topaz in a sand bath.

Colour altered by heat.

Another method is to wrap the stone in amadou, or German tinder, tightly bound round with tin wire,

and then to burn the tinder, when the topaz is found to be changed to a pink colour.

The same result can be obtained, but with somewhat more risk of failure, by embedding the stone in a large mass of clay or plaster of Paris, and then placing it in an oven, which is afterwards made very hot; when the oven has been allowed to cool gradually, the stone may be removed from the mass.

CRYSTAL OF BLUE TOPAZ
(ACTUAL SIZE).

Nearly all the pink topazes upon the market have been altered, or to use the technical term, "pinked" in this way. At the present time, they are much used in jewellery, and form a pleasing combination with the delicate green of the peridot, with which they are frequently associated in high-class ornaments.

Blue and green topazes.

Next to the pink variety come the blue and greenish in value. Although somewhat resembling the aquamarine in colour and general effect, these

varieties of topaz are much more brilliant, owing to their greater hardness.

The yellow and brown topazes are the most generally known variety, and at one time were used in considerable quantities for necklets, pendants, etc., as can be shown by referring to the jewels of the early part of the nineteenth century; they were afterwards quite at a discount for many years until recently, when there has been seen a tendency for a renewal of the bygone popularity of these effective gemstones.

CRYSTAL OF WHITE TOPAZ (ACTUAL SIZE).

Novas Minas.

The white variety possesses a wonderful degree of limpidity when properly cut and polished, but is not now in demand. The white topaz is sometimes known as "Novas Minas," from the locality in Brazil where the most beautiful specimens are found.

The limpidity and brilliancy of topazes vary considerably, especially in the white variety. Very large topazes are of no unusual occurrence. The topaz occurs in granite in company with tourmaline and beryl, and sometimes with tin, fluorspar, and apatite.

Localities.

The localities in which the topaz occurs are, amongst others, Brazil, Siberia, Asia Minor, Pegu, Ceylon, Victoria, Bohemia, Saxony, Connecticut (U.S.), and Japan. The finest specimens, however, are derived from Brazil and Siberia. The chief sources of the topaz in Brazil are Minas Geras,

Villa Rica, Novas Minas, the last named generally used in connection with the white variety. In Siberia the topaz occurs in many districts, notably the Altai and Ural Mountains; near Nertchinsk,

TWIN CRYSTALS OF TOPAZ.

and also in Kamschatka. If the recent announcement of the discovery of blue topaz upon the property of the South African Option Syndicate in Rhodesia be duly confirmed, yet another source of the supply of this variety of the gem is available.

CHAPTER XVII

GARNET—CARBUNCLE—CINNAMON STONE OR ESSONITE—DEMATOID

THE several gem-stones known to mineralogists as the garnet group differ considerably one from another in appearance and in the variation of their relative hardness, specific gravity, and chemical composition. They, however, all occur in the cubic system, and the chemical composition of each of the different varieties may be expressed by a similarly constructed formula.

Garnets occur in colours ranging through many shades of violet and brown to a delicate pink, also yellow, drab, green, black, and white; several of these varieties are, however, unsuitable for use in jewellery. They are monochroic and singly refractive; the lustre is vitreous; the fracture, sub-conchoidal; cleavage, very imperfect. They generally assume the form of the dodecahedron and icositetrahedron, perfect crystals being by no means unusual; they also occur in granular fragments. The garnets suitable for jewellery are transparent, but they also occur almost opaque. The red garnet, at all times, on account of its colour, has been frequently mistaken by the uninitiated for the ruby, and also by the unscrupulous, many fancy names, such as "Cape Ruby," "Ruby Garnet," and "Australian Ruby,"

have been applied to it, with a view to enhancing its market value.

The garnet does not form a good material for engraving upon, as it is apt to break during the process, but has, nevertheless, often been used for the

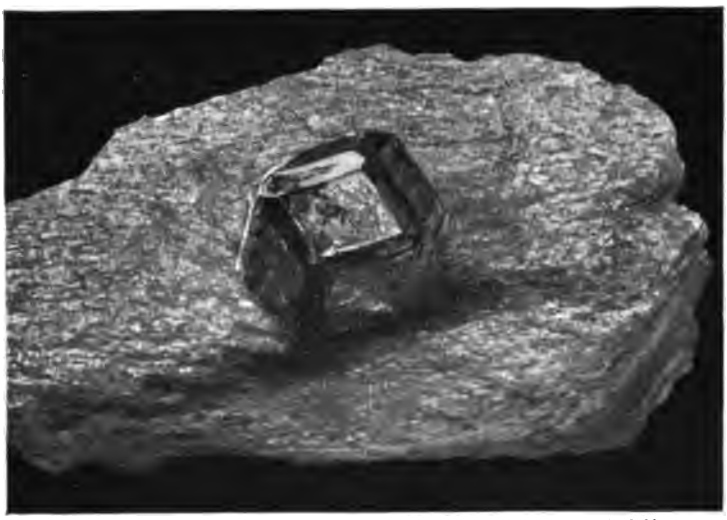
CRYSTALS OF GARNET (ACTUAL SIZE).

purpose. The name garnet is derived from the Latin word *granatus*, meaning grain-like.

Carbuncles. The purple, red, and brown varieties of garnet are sometimes cut *en cabochon*, when they are known as carbuncles. In this form they were previously in great demand, but in recent years have become almost obsolete as jewels, although used to some

extent for other decorative purposes. Occasionally a shimmering cross, like the elongated legs of a silvery spider, may be seen upon a carbuncle, presenting a somewhat similar effect to that of the star-stone or asteria, except that it presents only four rays instead of six.

Garnets may be said to occur plentifully in many



British Museum.

CRYSTAL OF GARNET IN MATRIX (ACTUAL SIZE).

parts of the world. Of the many different varieties the following are those which are of chief interest to the jeweller:

Almandine.

Almandine (iron alumina garnet).—This variety presents different shades of violet and purple. Although one of the least rare gem-stones, it forms, when of fine quality, a most decorative and effective one, the beauty of which can be greatly enhanced

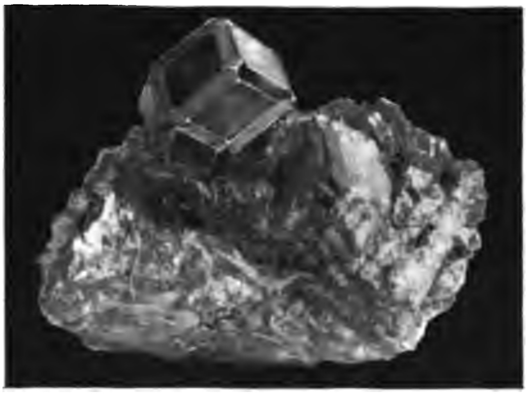
by careful and accurate cutting. Some specimens of this stone have, however, a tendency to be inky and blackish in appearance on account of the great density of the colour. Some almandine garnets exhibit a series of black bands when examined by the spectroscope, by which means they may be distinguished from red spinels (discovered by Professor A. H. Church).

The composition of almandine garnet is very variable, but the following will serve as an example: silica, 35.5; alumina, 21.0; iron protoxide, 35.5; magnesia, 4.0; lime, 2.5; manganese protoxide, 1.5; hardness, 7.3; specific gravity, 3.5-4.2. The localities of this variety of garnet are many, but those derived from Ceylon, Brazil, and Hindostan, are considered the finest quality.

Pyrope. *Pyrope* (magnesia alumina garnet).—The colour of this garnet is scarlet. It usually occurs in small pieces, and is cut in the form of the "rose," with a flat back, chiefly used in the cheap Bohemian jewellery. Hardness, 7.5; specific gravity, 3.7. Composition: silica, 41; alumina, 22.0; magnesia, 16.0; iron protoxide, 8.5; lime, 5.5; chromium sesquioxide, 4.5; manganese protoxide, 2.5. Pyrope garnets occur chiefly in Saxony and Bohemia. Some fine specimens have also been found in South Africa associated with diamonds.

Essonite. *Cinnamon Stone* or *Essonite* (lime alumina garnet).—The colour of this stone is a honey yellow, sometimes verging on toffee brown. It generally possesses the appearance of containing innumerable tiny seeds or grains of sand inclosed within it. It is often confused with the variety of jargoon called jacinth or hyacinth, under which name it is indeed

frequently sold. In fact, the name of jacinth, which, strictly speaking, should be applied only to the cinnamon coloured jargoon, is so generally used in connection with this variety of garnet that the term may almost be said to embrace both these stones, although they are distinctly different in every respect except that of colour. Hardness, 7; specific gravity, 3.5-3.7; composition: silica, 40; alumina, 21; lime, 33; iron



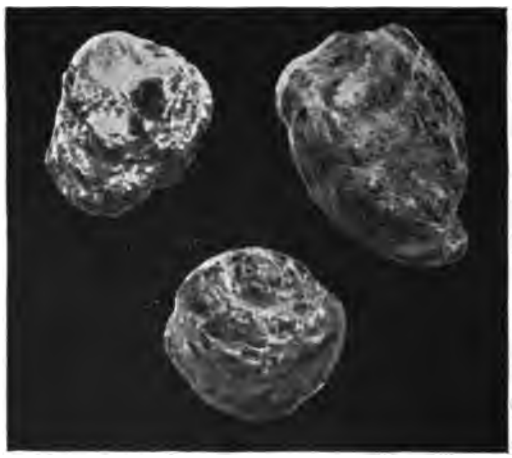
CRYSTAL OF ESSONITE (ACTUAL SIZE).

protoxide, 6. Essonites are chiefly obtained from Ceylon.

Dematoid or *Bobrowska.*—This gem-stone, which is included in the garnet group, although its identity is still somewhat in doubt, occurs in different shades of brown and green, sometimes approaching the colour known as verdigris green. It disperses and refracts the light to a great extent when properly cut, consequently it constitutes a most brilliant gem. In chemical composition it differs very little from that of the essonite, but the difference which exists

is sufficient to account for the variation of colour. Hardness, 5.5; specific gravity, 3.84. It is found in the form of peculiar little nodules about the size of one's finger nails, which have to be broken up into several pieces and the pieces cut into gem-stones as the white matrix penetrates the natural fissures of the stone, of which there are many, to a considerable depth. These stones occur associated with gold in

Method of treatment.



NODULES OF DEMATOID GARNETS (ACTUAL SIZE).

several localities of the Ural Mountains, notably on the river Bobrowska, to which they owe their name.

This beautiful gem ranks in value very much higher than the red and brown varieties of garnet already described. Many somewhat misleading names have been applied to it, such as "Uralian Emerald" and "Siberian Chrysolite." It is also frequently sold as olivine, and in fact as such it has become known to the public.

CHAPTER XVIII

PERIDOT—CHRYSOLITE

THE peridot is a variety of the mineral known as olivine. It is a limpid stone of a delicate green colour, somewhat resembling that of green Chartreuse. It was a most popular precious stone at the beginning of the last century when our grandmothers wore huge poke bonnets with mountainous decorations of plumes, enormous "leg-of-mutton" sleeves, and their waists just under their armpits.

Old-fashioned stone revived.

It was, however, in course of time superseded by other gems, more kindly favoured by Dame Fashion, and for upwards of fifty years this beautiful gemstone was, if not forgotten, at all events unappreciated. But when, at Her late Majesty Queen Victoria's first Jubilee, a revival of many of the fashions of 1830 took place, the quaint old jewels of our grandmothers were all brought again into the light of day, and the peridot was reinstated in its former position as a fashionable precious stone, which, needless to say, it has since occupied.

For many years it was from these old family jewels that peridots were derived to supply the still increasing demand for these gems, as there existed no record of the mines, which were, however, supposed to have been in the Levant, whence the original supply was obtained. Within recent years,

Found ready cut and carved.

however, peridots have been obtained from Egypt and "an island in the Red Sea" (Zeberghed), where they are said to be washed up on the seashore. They are found not only in the rough state, but (strangely as it may read) also in many cases cut and carved in a most elaborate fashion into figures resembling Buddha, little cylinders, etc. An explanation of this is said to be that the sea has encroached upon the burial-place of an ancient race, and the little carved figures of peridot are washed out of the graves where they were placed beside the dead perhaps thousands of years ago. I have on several occasions found one of these most interesting carved peridots contained in parcels of the rough stones which I have purchased in the ordinary way of business in London!

PERIDOT (ACTUAL SIZE).

Mystery of origin.

There was for some considerable time great mystery about the origin of the Egyptian peridots, for no one appeared to know the exact locality whence they came. My own idea upon the matter was that they were collected in remote districts by wandering Arabs, from whom they were purchased and taken to Cairo and Alexandria by travelling merchants, etc., who had no idea of the place where the stones were found. The district has, however, now been

located, and measures are taken by command of the Khedive to protect the gems.

The colour of the Egyptian peridot is very beautiful, but somewhat different from that of the old stones, being much more yellowish in tone, and seldom or never of the "leaf green" shade for which the latter are so famous.

A fine quality peridot forms a most beautiful gem, as the colour is rich and effective, and the lustre, although somewhat oily, is subdued and refined. Peridots of large size are by no means rare, but when of good colour they are greatly in demand.

Peridots in Meteorites.

Sometimes small crystals of this mineral are present in meteoric iron, and Professor Kunz mentions that he has obtained some weighing as much as one carat sufficiently green in colour to be called peridots, and clear enough to cut into gem-stones, from a meteorite that was found in Glorietta Mountain, Santa Fé county, near Mexico, in 1885.

The peridot, although not a very hard stone, is capable of receiving a very high polish, which is imparted to it by the application of sulphuric acid during the process of polishing; great care and skill are required to successfully manipulate this gemstone, as the acid will burn into and seriously damage the stone unless proper precautions are taken to avoid it doing so.

The hardness of peridot is 6.5 to 7, and the specific gravity 3.3 to 3.5. Chemical composition: silica, 39; magnesia, 49.3; protoxide of iron, 11.2; oxide of manganese, 0.3; alumina, 0.2. It crystallizes in the rhombic system, but the crystals are generally worn and broken, exhibiting only traces of crystalline form.

It is doubly refractive and dichroic; lustre vitreous; fracture imperfectly conchoidal.

The peridot and other varieties of the mineral olivine must not be confused with the beautiful green garnet, which is almost universally sold as olivine, a different stone altogether. It is much to be regretted that it has become customary to call the green garnet by the name of olivine, as much confusion arises therefrom.

CUT PERIDOT (ACTUAL SIZE).

Natural glass resembles the gems.

In consignments of rough peridots it is not unusual to find fragments of a natural glass which resemble the true gems closely enough to escape detection upon casual examination. The colour of this material varies considerably from leaf green to greenish-yellow, and when cut and polished the appearance is sometimes not unlike that of the peridot by daylight, but by artificial light it has a very glassy lustre. The specific gravity varies considerably in different specimens, but generally lies, I find, between 2.591 and 2.714. The hardness is about the same as manufactured glass. It is, of course, single refractive and non-dichroic. The name of pseudo-chrysolite has been aptly applied to this mineral. It is valueless as a jewel.

Chrysolite.

Chrysolite.—The chrysolite is a transparent yellow variety of olivine and is generally a delicate primrose

colour, otherwise its natural properties are identical with those of peridot. It, however, does not occur in such large pieces as the peridot nor is it found in such quantities. The chrysolite was generally used in jewellery in the early days of the nineteenth century, but went completely out of fashion and has never been reinstated, as was the case with the peridot. Perhaps the reason for this is that it bears a great resemblance to the topaz, although of a more pleasing and delicate appearance.

The word peridot is derived from the Arabic "feridet" (a precious stone). The peridot and chrysolite formed the topazius of the ancients, and frequent mention is made of it in the writings of Pliny and other early authors. The name "topazius" indicates "to seek after," and is said to be the same as that of an island where the stones were found, and which was continually shrouded in dense fog.

It is said that the peridot is a favourite gem of his Majesty King Edward VII.

CHAPTER XIX

EPIDOTE—IDOCRASE—IOLITE—SPHENE—AXINITE—DIOPSIDE

EPIDOTE occurs in different shades of yellowish green, sage green, hair brown, and dull red, some of which bear a resemblance to those of the tourma-


British Museum.

CRYSTALS OF EPIDOTE (ACTUAL SIZE).

line. It is of little interest as a gem-stone, and is seldom seen except in collections, for it does not particularly lend itself to decorative effect.

Only seen in collections.

The chemical composition is very variable, but

the following is that of a green crystal: silica, 37.6; alumina, 26; lime, 20.5; protoxide of manganese, 0.6; protoxide of iron, 13.5; water, 1.8. Crystalline system monoclinic. Translucent to opaque. Doubly refractive and highly dichroic. Hardness, 6. Brittle. Specific gravity, 3.24 to 3.45.

The finest crystals are found in the Tyrol, Ural Mountains, Brazil, and Connecticut. Different

CRYSTAL OF IDOCRASE (ACTUAL SIZE).

varieties of epidote are known by the following names: Zoisite, Thulite, Bucklandite, Pistacite, etc., which are applied to the different colours in which the mineral occurs.

Vesuvianite, or Idocrase

Only of interest to the collector.

When this mineral occurs sufficiently transparent for the purpose, it may be cut into gem stones, although it cannot be said to possess any pronounced

decorative properties. The colour is brown, green, or yellow of somewhat a dirty appearance. Slightly dichroic. Hardness, 6.4; specific gravity, 3.7. Crystallizes in the tetragonal system. Chemical composition: silica, 37.3; alumina, 23.6; protoxide of iron, 4; Lime, 29.7; magnesia and protoxide of manganese, 5.2.

It is found on Vesuvius, in the Tyrol, and in Siberia. When cut and polished, it resembles inferior specimens of tourmaline and zircon. Idocrase is only of interest to the collector.

Iolite

The iolite is a gem-stone which may be described as being more curious than beautiful. It possesses the property of pleiochroism in a very marked degree.

It is frequently blue, purplish blue, or lavender in one direction of the crystal, a drab in another, and a "dirty white" in yet a third.

Iolite occurs in the rhombic system, generally assuming the form of prisms, which are usually hexagonal. Transparent to translucent; doubly refractive; lustre vitreous; fracture sub-conchoidal; hardness, 7.5; specific gravity, 2.7; colours generally bluish-gray with a brown tinge. Chemical composition: silica, 48.42; alumina, 31.72; magnesia, 10.76; protoxide of iron, 8.32; protoxide of manganese, 0.3; water, 0.48.

Iolite is only of value as a gem stone when transparent and fairly free from flaws and feathers, generally present in great numbers, by which the beauty of the stone is greatly marred. The word

iolite is derived from two Greek words meaning "a violet stone."

This stone is also known as "dichroite," because of its dichroic property, and as "saphir d'eau," from its resemblance to sapphires of a palish colour. Although it is numbered among the gem-stones, it is rarely used in jewellery, for, as I have said, it is more interesting and curious than it is beautiful, owing to its lack of brilliancy. **Highly dichroic.**

The finest iolites come from Ceylon, and others from several districts in the United States, notably Connecticut.

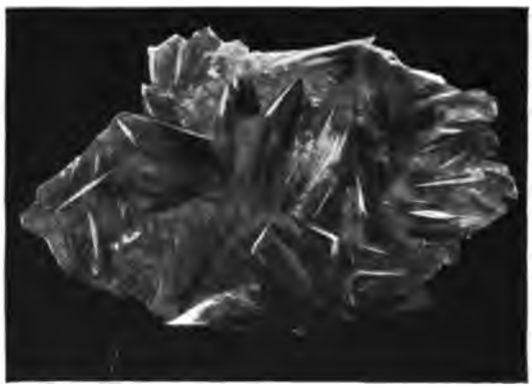
CRYSTAL OF SPHENE IN MATRIX (ACTUAL SIZE).

Sphene or Titanite

This gem-stone ranks among the most beautiful of precious stones, for it possesses the power of refraction and dispersion of light in a most remarkable degree. It appears in citron yellow to pale cinnamon colour, and is rarely colourless in the transparent variety, which alone is suitable for cutting as a gem-stone. The mineral also occurs opaque. Hardness, 5.4. Cleavage highly perfect, parallel to faces of prism. Specific gravity, 3.53. Crystalline system monoclinic; generally occurring in oblique rhombic prisms which are usually very thin and wedge-shaped at the edges. Doubly refractive and dichroic. Chemical composition: silica, 30; titanic acid, 42; lime, 28. **Brilliant gems.**

Sphene is not in general use in jewellery, partly because fine specimens are exceedingly scarce, but also on account of its softness, which causes it to easily scratch when in use. Its perfect cleavage renders it liable to break during the process of cutting and polishing.

The name sphene is derived from the Greek word "sphēn" meaning a wedge, and refers to the wedge-



CRYSTALS OF AXINITE (ACTUAL SIZE).

like shape of the crystals. The finest specimens of sphene have been found in North America.

Axinite

Rarely used as a jewel.

Very rarely used as a jewel, this mineral must be mentioned among the gems seen in cabinets and collections. In colour it is russet brown, plum, and gray. Transparent. Specific gravity, 3.25. Hardness, 6.6. Very brittle. Doubly refractive; trichroic. Chemical composition: silica, 44; boracic acid, 5.60;

alumina, 15.63; sesquioxide of iron, 9.20; sesquioxide of manganese, 3.05; lime, 20.68; magnesia, 1.20; potash, 0.64.

Diopside

A transparent crystal of diopside when cut as a gem-stone has much the same appearance as tour- **Unsuitable for jewellery.**

CRYSTAL OF DIOPSIDE IN MATRIX.

maline, of the same colour, with which it is sometimes confused. This mineral is, however, seldom cut and polished except as a curiosity. Hardness, 5.5. Specific gravity, 4. Colour, bottle green. Crystalline system, monoclinic. Doubly refractive and dichroic. Chemical composition:—silica, 55.2; lime, 24.5; magnesia, 16.5; protoxide of iron, 5.3; protoxide of manganese, 1.5.

CHAPTER XX

VARIETIES OF QUARTZ—AMETHYST, CAIRNGORM, CHALCEDONY, ETC.

OF the many varieties of the mineral quartz which are used as ornamental stones, the following are the most important. Not only do the different varieties vary considerably in appearance, but also slightly in hardness and specific gravity.

Rock Crystal is colourless transparent crystallized quartz. At all periods and in many parts of the world it has been largely used for ornamental purposes, sometimes elaborately carved and engraved into such articles as goblets, seals, etc., etc. It also is the material used by opticians to make "pebble" spectacles and lenses. It can scarcely be included in the list of gem-stones, for it is only used in cheap jewellery in the form of crosses, hearts, beads, etc. One kind of crystal bead called a "rondelle" is, however, cut and mounted in large numbers. These beads are inserted between strung pearls or drilled gems, and are very attractive. They are made very thin and quite round, with a flat on each side surrounded with small facets. Rondelles are used in ropes of fine pearls, Venetian chains, bracelets, etc.

Enclosures. Some specimens of rock crystal have enclosed within them acicular crystals of rutile, etc., massed together at every imaginable angle, presenting the

CRYSTALS OF ROCK CRYSTAL (ACTUAL SIZE).

appearance of brown or yellow hairs inside the transparent stone. The fancy name of "hair stone" has been applied to this form of rock crystal, which is used for seal handles and similar ornamental objects.

Rock crystal occurs in the hexagonal system, assuming the form of hexagonal prisms, which are sometimes terminated at both ends by hexagonal pyramids. Transparent; lustre, vitreous; fracture, conchoidal; uncleavable; hardness, 7; specific gravity, 2.5; composition, pure silica. Crystals of quartz sometimes assume immense dimensions, and are also frequently aggregated in large numbers.

This mineral is abundant in nearly all parts of the world, but the finest clear specimens are derived from North America.

Deceptive names.

All manner of different fancy names are sometimes applied to rock crystal in order to give it a fictitious value—some of these are "Cornish Diamond," "Brighton Diamond," "Rhine Stone," etc.

The word crystal is derived from "Krustallos," ice, from the belief of the ancients that it consisted of ice in a petrified state.

Amethyst.—This stone is a purple variety of transparent crystallized quartz. Amethyst varies in hue from the palest violet to deep plum colour; those of the darkest shade are most highly esteemed, those of pale colour being of little value.

Parti-colour.

It is not uncommon to find the purple colouring matter occurring only in patches, the remainder of the stone being white or nearly so; such parti-coloured specimens are considered the most desirable, and are often misnamed "Oriental amethyst." This expression belongs, strictly speaking, to the

purple sapphire, which is a gem of considerable rarity and value. By careful cutting, the colour of a parti-coloured amethyst can be caused to be reflected through the stone, giving the appearance of being the same colour throughout.

Amethyst although for some considerable time

ROUGH AMETHYST (ACTUAL SIZE).

neglected by the wearers of jewels, has now once more come into prominence as a fashionable gem-stone. It was greatly valued by the ancients, who employed it as a material for engravings and carvings, many of which still remain to us, forming striking examples of the glyptic art of bygone ages.

Amethyst being another variety of crystallized quartz, its composition, physical and optical pro-

perties are the same as those of rock crystal; it is, however, dichroic. The presence of a trace of oxide of manganese accounts for the purple colour of the stone.

Crystals of amethysts are seldom so distinct as in rock crystal, for they generally occur in groups of many different crystals united along the faces of the prisms, leaving only the pyramidal faces visible.

Curious fracture.

The result of breaking such a mass of amethyst along the direction of the prisms is that a peculiarly rippled fractured surface is presented. By the application of heat the purple colour of amethyst can be changed to golden brown.

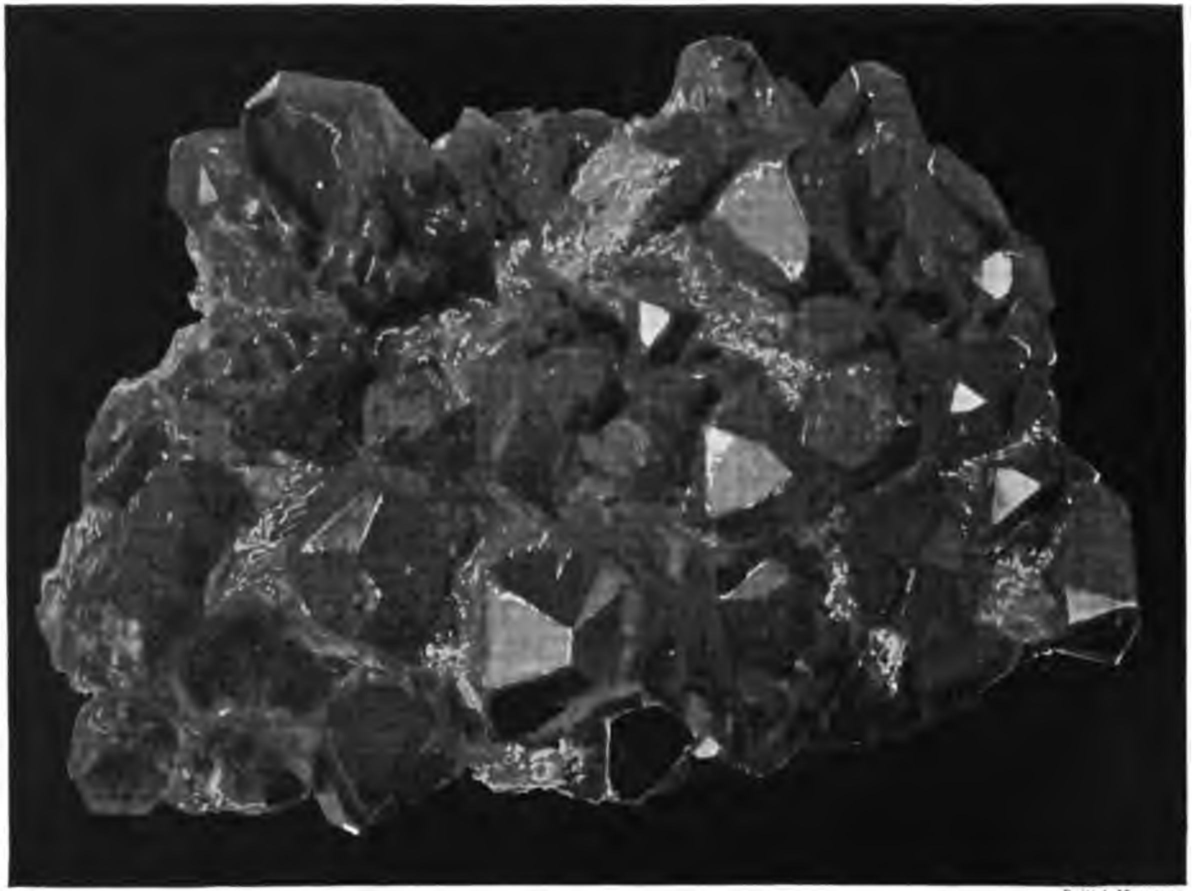
SECTION OF PARTI-COLOURED AMETHYST.

The finest quality amethysts are found in Siberia, India, Uruguay, and in Auvergne, in France; while the paler varieties are of common occurrence in almost all countries.

Cairngorm.—The yellow, brown, and smoky-brown varieties of crystallized quartz are known by a number of different names, which, however, are not quite synonymous, for some of them are used in connection with the different shades of colour in which the stone occurs. The principal of these are:

False topaz.

"cairngorm," "occidental topaz," "false topaz," "smoke topaz," "quartz topaz," and "citrine." This



British Museum.

AGGREGATION OF CRYSTALS OF AMETHYST (ACTUAL SIZE).

stone somewhat resembles the true topaz in colour, but is much less brilliant. Except in the difference of colour, it in every way resembles rock crystal. It is by no means a rare stone, and is consequently of little value, although rich dark-coloured pieces form effective ornaments when properly cut and polished. It is largely used in what is known as Scotch jewellery; for the ornamentation of presentation caskets; for fixing at the ends of antlers, etc.

CRYSTAL OF CAIRNGORM.

Rose quartz, a delicate rose-coloured variety of quartz which is semi-transparent and nearly always internally fractured. It generally occurs massive, but very occasionally in crystals. It is fashioned into all manner of ornamental objects, such as umbrella knobs, seals, cups, etc. The colour of this stone unfortunately fades upon exposure to light; moisture will, however, restore the original colour.

Milky quartz is semi-opaque, of a milk-white colour, which is massive in form; of very common occurrence. It is used to a small extent for ornamental objects, but has very little value.

Aventurine quartz.—This variety consists of common quartz disseminated with minute spangles of

bright-coloured mica. It varies in colour considerably, being brown, gray, or brownish-red, and is translucent. It is occasionally used for "inlay work," but is not effective. The imitation of this stone, consisting of glass to which in a molten condition have been added brass filings, is far more beautiful than the real stone, and is largely used for mosaics, etc., especially in Italy. The method of making this imitation aventurine was discovered by a workman accidentally dropping some brass filings into some molten glass. The name aventurine means "by accident," and it subsequently was applied to the real stone from its resemblance to the imitation. Aventurine is also sometimes known as "gold stone."

Imitation more beautiful than the real stones.

Chalcedony.—The structure of this stone is cryptocrystalline. It does not occur in crystals. It is transparent, and usually varies in colour from grayish-blue to brownish-white, but it sometimes occurs in different, more pronounced colours, to which separate names are given. The colour can be altered artificially. Its mode of occurrence is mammillated, botryoidal, or stalactitic.

Chrysoprase, or apple-green chalcedony, is a most pleasing colour, and was recently in great favour as a gem-stone. The best specimens come from Silesia and North America; the colour is due to the presence of nickel.

Prase is a rich sage-green translucent chalcedony. It is seldom used at the present day, but was a favourite material of the ancients for engraving intaglios.

Plasma is a sub-translucent chalcedony, sage-green in colour, spotted with white.

Carnelian is a translucent stone consisting of chal-

cedony of a raw flesh-colour verging towards brown. It is largely used for seals, signet ring stones, etc., and is oftened altered in colour artificially.

Sard.—This stone resembles carnelian very closely, but is somewhat less translucent and browner in colour; it often approaches liver colour, when it is known as "liver sard."

Agate.—This name is given to chalcedony when it has a variegated appearance with regard to colour. It sometimes consists of several different colours combined together in patches, straight and zigzag parallel lines, spots, concentric rings, etc. These markings are due to deposits of the chalcedony taking place in succession and under varying conditions during the process of formation. The different patterns thus formed often receive distinguishing names. One of the most

Moss agate. pleasing of these is the "moss agate." It is generally whitish-brown in colour with a delicate pattern resembling a maidenhair-fern, a small tree, seaweed, etc. The appearance sometimes is exactly as if some such object were actually beneath the surface of the stone, but it is really due to the infiltration of some foreign colouring matter into the stone. Another well-known form of agate is known as "fortification agate." It consists of irregular parallel lines of different colour, and bears its name from a fanciful resemblance to the outline of a fortification. "Eye-agate" consists of concentric rings of various colours one within the other, the centre being a spot of dark colour. Some specimens of this stone are very decorative, and deserve to be much more largely used than happens at present. The name of "riband agate" is given to this stone when the colour occurs in straight parallel bands. Agates are cut into vases,

dishes, goblets, buttons, seals, etc., and can be altered in colour artificially.

Onyx.—This stone consists of horizontal layers of brown and opaque white chalcedony. It is chiefly used as a material for engraving cameos; the white layer being used for the design and the dark layer for the background. Sometimes a third layer can be utilized in the design with good effect. The dark brown layers are generally made black artificially. Most of the best ancient and modern cameo carvings are executed upon stones of this description—used for mourning jewellery. **Used for cameos.**

Sard-onyx is a similar stone to onyx, but the layers consist of sard and white chalcedony alternated.

Quartz cat's-eye.—This is a variety of quartz which somewhat resembles the true cat's-eye in appearance, although of far less beauty. It is greenish-gray in colour. When cut *en cabochon* it presents an appearance resembling the iris of a cat, caused by the presence of fibres of asbestos. It is used in inexpensive jewellery, but is of very little value.

Jasper is a massive variety of quartz which occurs in a variety of different colours, such as red, yellow, brown, and green. It is quite opaque, even when in very thin splinters. The colours are frequently in parallel bands, when the stone receives the name of "riband jasper."

Bloodstone or *Heliotrope* is a dull, sage-green variety, translucent to almost opaque. It owes its name to the presence of blood-red spots, and is used chiefly for signet-ring stones.

Many of the last named varieties of quartz, particularly jasper, carnelian, sardonyx, onyx, and blood-

stone were used to a great extent by the ancient Greeks and Romans for the purpose of engraving cameos and intaglios. Some of these exquisite works of art are still extant and may be seen in our museums to-day.

CHAPTER XXI

PRECIOUS OPAL

IT is impossible for anyone to adequately describe the wonderful beauty of a fine opal, ever changing to some new and beautiful effect, as the direction of the light upon the stone is altered. The flashing spangles and stripes of brilliant colour have nothing in nature to which they can be compared.

However, I think Pliny described the opal, as displaying all the colours of all the other gems glowing together in combination; and other early writers, as resembling the flame of burning sulphur, or of a fire made alive with oil. Mineralogists distinguish the opal used in jewels from the other varieties of the mineral of that name by the title of "Precious" or "Noble opal," but this prefix is not used except for that purpose.

The opal is a mineral consisting of silica combined with from five to twelve per cent. of water; the hardness is 5.5 to 6.5; specific gravity, 2.21; lustre, vitreous.

The varieties of opal which do not present the prismatic flashes of colour, and which are generally opaque, are almost valueless. They sometimes occur in shades of white, yellow, red, green, brown, and gray, and are occasionally banded and marked with

two or more shades, assuming very much the appearance of agate.

The diaphaneity of precious opal varies from almost opacity to translucency. The brilliant effect of colour of the gem is in no way connected with the colour of the material itself, which is of a nondescript quality, generally resembling by transmitted light, that of soapy water, but often inclined to be yellowish.

Sir David Brewster's theory.

The generally accepted theory of the cause of the flashes of colour displayed by this gem is that put forward by Sir David Brewster. It is that the stone is internally traversed with undulating fissures of microscopic minuteness, upon which refraction and decomposition of light take place.

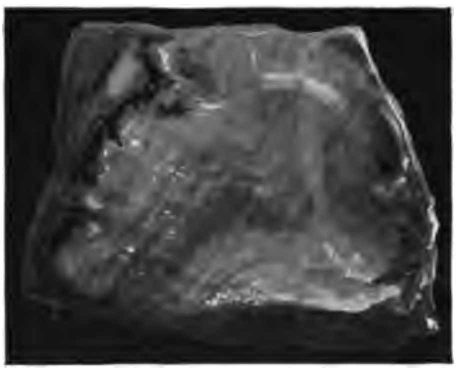
Pattern.

The variations in the nature of these minute cavities cause the appearance of the opal to vary considerably, and the different effects of colour thus produced are technically known as the "pattern" of the gem. In some opals the flashes are of several different colours equally mixed together and of uniform size, and evenly distributed throughout the stone, while in other specimens the different colours are disposed in layers, stripes, or patches, or one colour may prevail entirely. Also the shape and size of the spangles and flashes vary from the same cause; sometimes they are so minute that the opal bears the name of "pins-point" opal, while when squarish and uniform in size it is known as the "harlequin" opal.

Formerly the harlequin opal was the most highly valued, but latterly there has developed a preference for the gem possessing large flashes of flame-red and brilliant green.

Great skill is required in cutting opals from the rough, as sometimes, as I have said, the spangles of colour are displayed in patches, or in layers of different colours, one upon another, so that looking at the stone edgeways a striped appearance is presented. Therefore, according to the angle at which the gem is cut, an entirely different effect may be produced, and it is the business of the lapidary to select the one which will result in the most valuable

Skill in cutting.



ROUGH QUEENSLAND OPAL.

gem, consistently with the shape and other natural peculiarities of the piece of raw material upon which he is operating.

Hungarian opals.

Formerly the only source of opal was Hungary, whence the gem has been derived from the earliest ages; although it has been found in considerable quantities in that country, fine specimens are seldom met with in our days.

The Hungarian opal is of a peculiar appearance, being almost colourless and either transparent when

held up to the light, presenting in fine specimens very large and varied flashes of colour. The matrix, in Hungary, of the gem is andesite.

Australian opals.

Australia supplies the market with opals of great beauty and in considerable quantities; in fact, so large has been the supply of Australian opal during recent years that the value of this beautiful gem has greatly decreased.

In Queensland the opal is found in a hard, dark brown iron-stone, and occurs in irregular veins of greater or less thickness, or disseminated through the rock which generally is found in the form of boulders. The most notable locality for opals in Queensland is Sandy Creek, situated about 90 miles distant from Winton, and 125 miles westward of Longreach.

New South Wales also produces opals of fine quality, but of a somewhat less transparent nature than those of Queensland. White Cliffs, situated in the dry western county, about 780 miles from Sydney, and 65 miles from Wilcannia, is the principal locality in New South Wales for opal mining. The whole of the surrounding country is rich in valuable minerals, but the great scarcity of water is very detrimental to prospecting. The opal-producing area in this district is about 15 miles long by about 2 miles in width.

Opal seeking.

To Mr. John Plummer of Sydney I am indebted for the following description of the methods of opal seeking: "Prospecting for precious opal is a decidedly hazardous business, because, as a rule, there are no indications whatever on the surface of the occurrence of the mineral below. It is only in very rare instances that an outcrop of the gem can be

seen, and the usual procedure is to dig a trench or pit in such a position as fancy may dictate and trust to luck. Fortunately, sinking is easy, as the rock is of a soft nature, and in a fair number of instances the opal has been met with at a very short distance from the surface, though a large majority of the pits are unsuccessful. For several years the belief existed among miners that it was useless to prospect for precious opal at a greater depth than twelve feet from the surface; but of late the incorrectness of this view has been proved, and the stones have been discovered at a depth of nearly fifty feet."

Opal pseudomorphs.

Some very interesting pseudomorphs in opal are found at White Cliffs. Not only do these occur after wood, showing the grain and bark as distinctly as in the original material, but also bones and several different kinds of shells. A very fine specimen, consisting of the humerus of an extinct reptile, may be seen at the British Museum. This specimen measures eight inches in length, and a portion measuring at least six inches has become changed into hydrated silica, possessing the characteristic flashes of precious opal which can be seen to advantage upon the fractured surfaces. In opal pseudomorphs the change is a gradual one, the original material being replaced particle by particle by the silica until the whole mass is converted into opal, which, however, retains the form of the primary object. At one time these specimens were of such rarity that they commanded a high price as museum specimens, but latterly, as large numbers have been found, they do not maintain such commercial value.

Mexican opal.

In Mexico a very transparent variety of opal occurs of a golden yellow to orange-red colour. It

British Museum.

PSEUDOMORPH IN OPAL. AFTER BONE OF AN EXTINCT REPTILE (LESS THAN ACTUAL SIZE).

exhibits the characteristic flashes of fire of the precious opal, but generally to a limited extent; it is not much used in jewellery on account of its very gelatinous appearance, and is therefore not of much value.

Other varieties. There are other varieties of opal which are of little interest in connection with jewellery. Hyalite is transparent; hydrophane is a variety which readily absorbs moisture, and although not naturally transparent, becomes so (and sometimes also prismatic) on being immersed in water. Cachalong is the name given to those specimens of hydrophane which adhere to the tongue.

When the opal occurs in such thin veins running through the matrix that it is impossible to extract it and cut it up into gem-stones, a very good effect is obtained by cutting the opal together with the matrix. A stone cut in this way is called an "opal matrix."

If the matrix be black or dark brown, as in the Queensland stones, and the veins of opal in it are brilliant, as is the rule with the small veins of the gem, the contrast of the rainbow colours of the true opal upon the dark background is particularly pleasing.

Opal cameos. The material is often carved as cameos, and by introducing the brilliant colouring of the opal into the design a most excellent effect is obtainable. As an example of the work to which I refer, I may mention a carved head of a North American Indian, which was carved in the black matrix, while the patches of opal were utilized as the headdress of feathers, barbaric jewels, etc.

In fact, there is wonderful scope for much artistic

work upon this beautiful material, which by its natural appearance inspires the artist to choose a suitable subject. For instance, an opal matrix may suggest the brilliant colouring of the setting sun over an emerald green stretch of sea, which by the conversion of a spot of dark brown matrix into a barque becomes an ideal subject picture; the brilliant plumage of a bird of paradise, or the scales of an imaginary dragon-like monster, can be designed to utilize to advantage the peculiarities of each individual piece.

But the carved matrix has been "done to death," not only by the influx upon the market of badly-cut stones, but by the bad judgement of artists who depict, perhaps, a woman's head carved upon opal with flashes of fire all over it, the effect being that of a skin disease rather than an object of beauty.

The non-existence of any antique cameos upon this material may be explained in two ways. Firstly, the opal is not sufficiently strong to withstand the wear and tear of ages, and secondly, the only opal possessing a dark matrix is that from Queensland, which was unknown to the ancients.

The bad luck of the opal.

It would be useless to deny that opal, one of the most beautiful and interesting of gems, has suffered much by falling a prey to the superstitions of bygone days; although it is purely a case of "giving a dog a bad name," the opal still smarts under the stinging appellation of "unlucky." Yet no one can say for certain why or how the stone was originally associated with ill-luck, although many reasons have been given in explanation. I have, however, heard a very plausible account of the origin of the superstition.

Two and a half centuries ago, at a time when the opal was largely used in jewellery in Europe, a terrible plague wrought havoc throughout Italy, where the jewellers were especially famous for their artistic creations, among which opals occupied an important position.

While Venice, together with other cities, was suffering from the scourge, someone with unusual powers of observation noticed that an opal worn by a victim of the plague became more brilliant when the patient was at the point of death, while it lost, or partially lost its lustre after death had taken place. The superstitious easily persuaded themselves that the opal had some malignant influence upon the destiny of the victim, for the use of common sense in such matters was probably rare at the period of which I am writing. It never occurred to them that it was not the opal which caused the death of the patient, but the death of the patient which caused the alteration in the appearance of the gem by the change of temperature from fever heat to the chill of death. For there is no doubt that the brilliancy of the opal does alter slightly—but very slightly—by variation of temperature, as is shown by the effect produced by the wearer of an opal ring possessing a warm or cold hand.

"Anne of Geierstein."

Sir Walter Scott made the opal bring ill-luck to the wearer in "Anne of Geierstein"; but this was not sufficient to account for the prejudice against the gem being so prevalent until recent years, even if it had not previously existed. Happily, on account of its great beauty, the opal is recognized to-day among the gems which are never "out of fashion."

An amusing anecdote has been told of a rich city

financier, who recently took his "opal ring" to a jeweller, and offered to sell it because of the ill-luck it brought him. A whole tale of woes was poured out as the result of having worn the ring! his wife's illness, death of a son, financial difficulty, ill-health, and many other troubles, were in turn recounted. The jeweller, however, with a smile, informed him that the stone in the ring was a star-stone, and that his own imagination had endowed it with such unpleasant properties.

To the ancient Greeks a stone was known called Ophthalmius, or eye-stone, and it is conjectured that the opal (opalus) of the Romans was the same stone. Possibly for the same reason that peacock's feathers are supposed to be unlucky because of the number of eyes always spying upon one, the opal or eye-stone, acquired the same reputation! "Ophal," the old way of spelling the name of the gem, which was in use as late as the reign of Queen Elizabeth, is derived from *Ophthalmius* (King).

Ophal.

Amongst the innumerable tales told of the ill-luck of the opal, the story of Alphonso XII of Spain was given by the late Mr. Clement Scott in the "Free Lance." The monarch is said to have presented a magnificent opal ring to Mercedes, his first wife, on his wedding day. She shortly died, and Alphonso gave the ring to his sister, who died in a few days; after her death he gave the opal to his sister-in-law, with the same result—he then wore the ring himself, with fatal consequence!

Was all this due to the opal? one asks with a smile of incredulity; or were there imperfect drains at the court of Alphonso, or some other equally adequate reason for such a series of catastrophes?

Of course, the only sensible explanation of the superstition regarding the opal is that, being one of the softest of gems, it is easily scratched when worn as a jewel. Sometimes when a gem has been in wear for some years, or is carelessly handled, the surface becomes dull and scratched to such an extent that the beauty of the stone is greatly impaired, and the wearer is apt to think that a permanent alteration has taken place in it which may portend some awful catastrophe; but by the expenditure of a few shillings the surface of the gem can be restored to its original condition, and the beauty and brilliancy of the jewel will be regained.

A reasonable explanation.

The opal has hitherto defied the manufacturers of paste and other imitation jewels, for they have failed to produce anything at all resembling a real opal.

CHAPTER XXII

TURQUOISE, OR CALLAITE—"FOSSIL TURQUOISE"

UNLESS we compare it to an Eastern sky, it is extremely difficult, if not impossible, to describe the colour of a fine turquoise without making use of the expression "turquoise blue," just as "emerald green" alone conveys the colour of an emerald. Turquoise varies, however, in depth and tone of colour from almost white, through countless shades of blue and bluish-green, including one which may be compared to the delicate tint of an hedge sparrow's egg, to the accepted shade of the gem, and in still darker tones to almost azure blue.

The name of this gem is probably French, derived from "Turkey."

Persian and Egyptian turquoise.

Turquoise is opaque or nearly so. Lustre waxy. Hardness, 6. Fracture conchoidal. Specific gravity, 2.7 to 3. Composition: phosphoric acid, 30.8; alumina, 44.6; oxide of copper, 3.7; protoxide of iron, 1.9; water, 19. The gem occurs in the form of veins and nodules.

The finest turquoises are found in Persia in a mountainous district lying round Mishapur.

A variety of the gem is derived from the Sinai Peninsula, and this is known in the trade as Egyptian turquoise. It possesses a pleasing colour, but it is less esteemed than the Persian, on account of its somewhat glassy appearance.

Large quantities of turquoise are found in the United States, notably in New Mexico; the mineral, however, occurs in a vast area, extending from Arizona as far east as Alabama. The American turquoise is not to be compared with the Persian and

TURQUOISE IN THE FORM OF A VEIN.

Egyptian varieties of the gem, being more porous, of a less pleasing colour, and incapable of such high polish. Large quantities of it are on the market, and it certainly forms a highly decorative material, although unsuitable for high-class jewellery. Turquoise occurs in the form of thin veins in the slate

schists in New South Wales; Gippsland, Victoria, and Wanganilla, Queensland. It is reported to have been discovered in the Murchison District in Western Australia, occurring in large masses, but up to the present time, Australian turquoise has been considered of little importance, owing to the thinness of the veins.

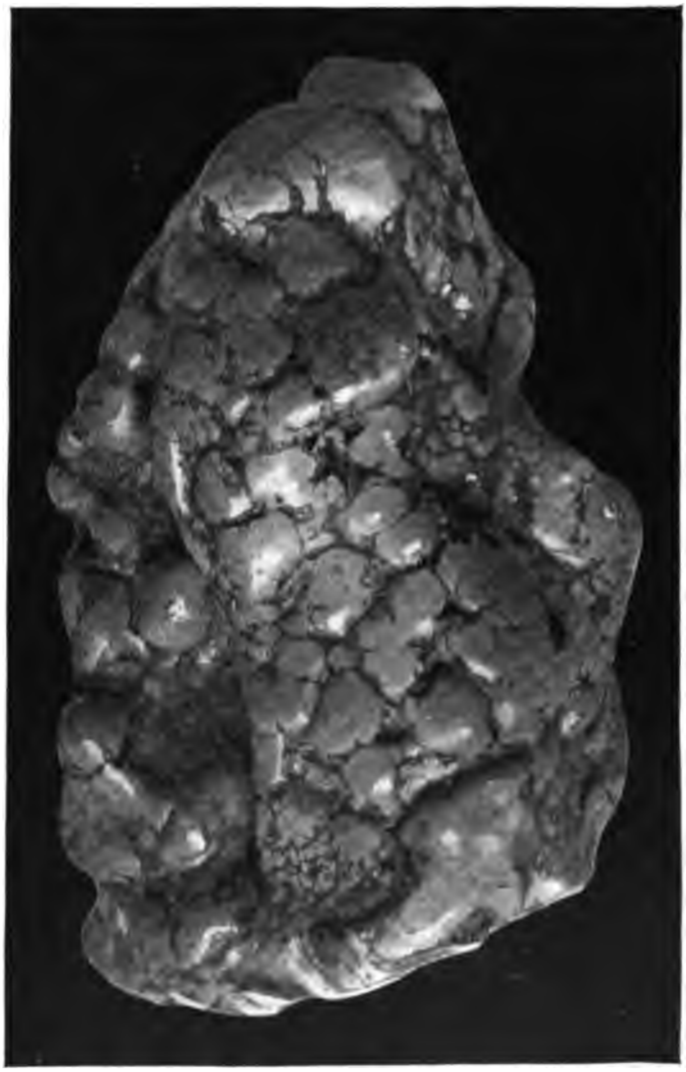
Turquoise has been used as material for jewellery from the most remote ages, for the bracelets discovered at El Mehesna, which are the oldest jewels known, contain beads of this gem alternated with beads of gold.

This is a popular gem for use in the best jewels, as its delicate colouring is not to be seen in any other precious stone. An undeniable drawback is its liability to change colour and assume a decided green tinge. American turquoise is most at fault in this respect. The use of perfume has much to answer for in this connection, also wearers of these gems should keep them free from contact with acid or grease. Superstition, as might be expected, has taken hold of the tendency of the turquoise to change colour, and has laid down her law that when the colour of the gem changes, the giver is in danger, and also, if the giver be a lover, fickleness is indicated.

Fossil turquoise.

Odontolite, or *Fossil Turquoise*, is a substance somewhat resembling the real turquoise, but consists of nothing more or less than fossilized ivory and bones of extinct animals coloured by phosphate of iron. Upon close examination the bony structure of the material can easily be detected. "Fossil turquoises" are seldom met with nowadays, and are of small value.

The true turquoise can be dissolved in muriatic



British Museum.

IMMENSE NODULE OF TURQUOISE (LESS THAN ACTUAL SIZE).

acid without effervescence, and if ammonia be added to the solution, it will appear a dark blue colour. This is a ready means of distinguishing a turquoise from a "fossil turquoise," but it can only be used if the stone be of no value, or a worthless fragment broken from an important piece.

CHAPTER XXIII

NEPHRITE OR JADE—JADEITÉ—MOONSTONE—SUNSTONE

NEPHRITE or jade is a compact variety of actinolite or tremolite. It is remarkable for its great toughness, which renders it very difficult to cut and polish. Its colour is rich sage-green, and also grayish-white. Opaque. Fracture splintery. Hardness, 6.5; specific gravity, 3.1.

The imperial green. This stone was highly valued by the ancients. In India and China it is fashioned into all manner of decorative objects and is greatly prized, especially in its white, and what is known as the "Imperial green" varieties. The sage green variety is worked in Alaska and New Zealand, chiefly by the natives who overcome the extreme hardness in a most wonderful and, to Europeans, unaccountable way. It is sometimes known as New Zealand "green stone," also "axe stone."

There are no mines of jade known, but it is found in isolated boulders in the countries above mentioned.

Jadeite.—This stone bears a great resemblance to jade in many respects, and is consequently often confused with it. It is harder and heavier than jade, but the colour is similar. It is equally valued by the Chinese, who carve it elaborately into images, etc. Jadeite is a compact alkali pyroxene.

ADULARIA OR MOONSTONE—SUNSTONE

The variety of orthoclase felspar known as adularia, which constitutes the moonstone of jewellery, is nearly colourless, transparent or semi-transparent, and displays a silvery, shimmering reflection when light falls upon it in a certain direction.

The moonstone is cut *en cabochon*, and by careful cutting, it should be arranged that the reflection or "blush" appears in the centre of the stone; this can also be regulated to a certain extent by making the convexity of the stone more or less. In other words, when the cabochon is a low one, the reflection extends more over the surface of the stone than when it is a high one.

NATIVE-CUT MOONSTONE.

All sent to Europe crudely cut.

In Europe it is very unusual to see moonstones in the uncut state, as before consignment they are always crudely cut by the natives of Ceylon, the principal source of the gem-stone.

In order to make the stones suitable for European jewellery, it is necessary that they should be re-cut, for the native lapidaries entirely ignore the direction in which each stone should be cut in order to display the effect already described, with the result that the reflection seldom appears in the centre, and as often as not it is nearly on the edge of the stone.

British Museum.

CRYSTALS OF ADULARIA OR MOONSTONE (ACTUAL SIZE).

The moonstone is suitable for use in less expensive jewels on account of the delicate effects which can be obtained by its use in conjunction with coloured stones to form a contrast, and also, being a stone of comparatively small value, important ornaments can be created with it at little cost.

Although large quantities of moonstones are from time to time upon the market, stones of any considerable size are generally difficult to obtain. The quality which is most highly valued is that which displays the reflection of bluish tones of colour instead of pearly white.

Chemical composition: silica, 65.69; alumina, 17.97; potash, 13.99; lime, 1.34; soda, 1.01. Specific gravity, 2.38. Hardness, 6. Crystalline system, monoclinic.

Sunstone. Another variety of adularia contains minute scales of yellow mica, which give it a spangled appearance. It is known as "sunstone" but is seldom used in jewellery.

CHAPTER XXIV

HAEMATITE — THOMSONITE — CROCIDOLITE — CHIASTOLITE — MALACHITE — CHESSYLITE — LABRADORITE —LAPIS LAZULI

THE Haematite used in jewellery is an oxide of iron, which, when cut and polished, has the appearance of highly polished steel. It is used chiefly for buttons, links, charms, etc., and for making imitation black pearls. Powdered Haematite is red, and stains the hands of the craftsman at work upon it.

Almost opaque, brittle. Fracture, subconchoidal. Hardness, 5.5; specific gravity, 4.6 to 5.2. Chemical composition: iron, 6.9; oxygen, 31.

Haematite is of no value.

THOMSONITE

This gem is opaque, and is therefore seen to the greatest advantage when cut *en cabochon*. The appearance of the stone can best be described as mottled, although spots and concentric rings figure conspicuously in the pattern. Several delicate shades of green, varying from pistachio to sage, a curious shrimp-pink, a greenish yellow, and a good Chinese white are comprised in the many subdued tints which combine to produce an almost endless variety of effects. The different colours and shades of colour

Curious colouring.

take no definite form, but occur in patches of irregular shape which intermingle, also a spot of one colour is frequently surrounded with zones of several other tints.

The composition of thomsonite is: silica, 40.17;

ROUGH CROCIDOLITE.

alumina, 23.23; soda, 4.8; lime, 10.1; water, 13.70. The specific gravity is 2.33; hardness, 5-6.

Crocidolite

The gem-stone used in jewellery known as crocidolite is a quartz pseudomorph after the mineral bearing the same name, which has much the same character as asbestos. It presents the appearance of innumerable fibres of a yellow greenish-gray or

reddish colour, closely packed together, parallel to each other.

Tiger's eye.

When cut with a convex surface this stone presents a shimmering line down the centre somewhat resembling a cat's-eye, and is sometimes known as "tiger's-eye" or "crocidolite cat's-eye." It occurs plentifully at Orange River, South Africa, and has been brought to Europe in such large quantities that its value has very greatly decreased.

CROCIDOLITE—CUT AND POLISHED TO FORM "TIGER'S-EYE."

It is now used for knife handles, table tops, bowls, letter-weights, etc., whereas at one time, comparatively recently, it was sold by the carat and used as a gem-stone in good-class jewellery. It can be artificially stained, and most striking effects can be obtained by the process. Its hardness is the same as quartz. Composition: silica, 50.64; protoxide of iron, 34.38; soda, 7.19; magnesia, 3.64; water, 4.15, with traces of lime.

CHIASTOLITE

It is possible to describe most precious stones by comparing them more or less with each other: a sapphire is like a ruby, only blue; a peridot resembles an emerald, except that the green is of a yellower tone, and the brilliancy somewhat oily, and so on; but the chiastolite cannot be described in this way, for it is quite unlike anything else. It is an almost opaque stone of a delicate nut-brown colour, shading in different specimens into a mouse-gray; it also has curious black markings which take the form of a weird cross, the arms of which extend to the edge of the stone and terminate in triangular black patches; also in the centre of the stone, where the arms of the cross meet, there is a diamond-shaped blotchlike patch. The effect of the black pattern upon the soft colouring of the background is most striking and effective, and from a purely artistic point of view commands popularity for the gemstone.

Not only does the colour of the background vary almost in every specimen, but the cross has also a different appearance, in some stones presenting a large central black patch and small triangular ones, and in others, hardly any centre and very large triangular terminations to the arms; the lines representing the arms of the cross are, however, always at the same angle, forming what is generally known as a Maltese cross. Therefore it is almost impossible to find two stones, even out of a large quantity, exactly alike in colouring and pattern, adding perhaps another charm to this really remarkable stone.

Maltese cross.

The chiastolite is cut *en cabochon*, that is, with a convex surface like a cat's-eye, and receives, and also retains, a high polish. It was due to the cross-like marking of the chiastolite that the attention of the superstitious was first directed to this stone, originally discovered several centuries ago in Andalusia, Spain.

In olden days so great was the demand for specimens of this gem-stone by the pilgrims to the shrine of St. Iago de Compostella, who paid enormous sums for the stones under the belief that they were endowed with almost miraculous virtues, that they ceased to be procurable in the district.

From the cathedral of St. Iago de Compostella, the French, in 1809, carried away as loot a most beautiful specimen of chiastolite. It formed the centre of a diamond ornament which, with other jewels of great value, adorned one of the figures on the altar. It is said that the markings on this stone took the unusual form of a blood-red cross, and that it was held in the highest degree of reverence by the Spanish people, who made many unsuccessful attempts to obtain re-possession of it. It afterwards belonged to Murat, King of Naples, and is to-day a valued possession of a wealthy French family. Many beautiful chiastolites are owned by the old Spanish families of Cadiz, Granada, and Seville, and it is said that they value them more highly than any other precious stone on account of the good fortune which accompanies them.

The finest specimens of chiastolite are found in Massachusetts, U.S.A., and Australia; but several European localities produce this gem-stone in small quantities and of inferior quality.

Popular in America. The stone has latterly become popular in America, where it is considered a talisman of prosperity, happiness in love, fidelity in friendship, and good luck.

The chiastolite (from the Greek *chiastos* = crossed) is a variety of the mineral andalusite, which is named after the province of Andalusia in Spain, where it was originally found. It crystallizes in the rhombic system, and occurs in rhombic prisms. Chemical composition: silica, 37.77; alumina, 62.23. The peculiar markings are due to impurities taken up by the mineral during the process of crystallization. The effect described is obtained by cutting the stones from sections, made at right angles to the length of the crystal. It varies from translucent to opaque in different specimens; lustre, vitreous; hardness, 7.5, tough; specific gravity, 3.1; fracture, uneven; cleavage, lateral, distinct.

MALACHITE—CHESSYLITE

Malachite.—This is an opaque stone of a vivid verdigris-green colour, presenting a mottled pattern of concentric rings and curves. It generally occurs massive with a stalactitic globular or botryoidal form. Very rarely crystallized. Hardness, 3.5 to 4; specific gravity, 3.6 to 4; fracture, conchoidal; lustre, vitreous and frequently silky. Chemical composition (Phillips): carbonic acid, 18.5; protoxide of copper, 72.2; water, 9.3.

This stone, which is capable of receiving a high polish, is used in mosaics, and in the form of a veneer for tables, vases, etc., principally in Russia, where it is greatly valued. By cutting it into thin slices and closely fitting them together edge to edge,

the concentric curves of the pattern can be made to assume a most elaborate design, but the colour of the stone is crude and does not appeal to the modern taste.

Chessylite is a mineral closely allied to, and greatly resembling, malachite. It is, however, a rich indigo blue in colour. Sometimes the two minerals occur intermingled together, and may be cut as one stone. In this case, the two colours, vivid green and Prussian blue, are both presented with a most *bizarre* effect.

Labradorite

This stone is a felspar which exhibits brilliant chatoyant splashes of colour when turned at a certain angle to the light, otherwise it possesses only a dull gray or brownish appearance. The gleams of colour displayed are red, blue, green, yellow, orange and purple, all of a most vivid hue. In much the same way as the shimmering reflection is only noticeable in the moonstone when held or cut at the correct angle, so the labrador spar only displays the brilliant flashes of colour when similarly treated.

Gleams of Colour.

This stone is difficult to cut or work into any object of art, as it is generally fractured with natural cracks crossing each other at right angles. Although a most beautiful object for the cabinet, labrador spar is unsuitable for jewellery, and has practically no commercial value.

Labradorite is translucent in thin pieces. Chemical composition: silica, 52.8; alumina, 30.4; lime, 12.3; soda, 4.5. Hardness, 6; specific gravity, 2.66 to 2.75.

It is principally derived from the coast of Labrador.

Lapis-Lazuli

This gem-stone was known to the ancients under the name of Sapphirus, and was greatly valued by them on account of its beautiful azure blue colour. It is opaque except at the edges of very thin splinters. Very frequently it is mottled with white spots, which greatly detract from its beauty and value. It is also usually marked with specks of iron pyrites (often erroneously supposed to be gold).

Lapis-lazuli has always been appreciated as a decorative stone, and has at different periods figured in jewellery in the form of beads, crosses, etc.

Ultra-marine. It is principally used at the present day for seal ring stones, as it is an excellent material for engraving. From this stone the pigment ultramarine was formerly obtained, but chemically manufactured material has for many years been used instead.

Chemical composition: silica of alumina, lime and soda, with sodium and iron probably as sulphides. Hardness, 5.5; specific gravity, 2.37; lustre, vitreous; fracture, uneven.

The finest quality lapis-lazuli comes from Persia, but an indifferent quality is found in Chili. Some agates may be stained to cleverly imitate this stone.

CHAPTER XXV

IMITATIONS OF PRECIOUS STONES—ARTIFICIAL PRODUCTION OF GEMS—ARTIFICIAL ALTERATION OF GEM STONES.

Theatrical gems.

IMITATIONS of precious stones.—The majority of imitation precious stones consist of glass. Those which are used for theatrical purposes are made of ordinary glass of various colours, which is in most cases not cut and polished in the same way as are real stones, but is moulded, or, to use the technical word, "squeezed" into the semblance of gems.

This is done by means of pincers which bear the mould or impression of the shape and surface facets of a number of precious gems. The pincers are applied to the glass when in a semi-molten condition, and in this way a good many of the glass gems are made at the same operation. After cooling, they are removed from the pincers, and are found to be connected together by a film of the glass material in much the same way as many varieties of sweets and galipots are joined together, owing to their being manufactured by a similar method.

They have then only to be detached to be ready for use, and to take their place among the sham jewels of a stage court.

When it is necessary to represent at a distance

rubies, emeralds, etc., as large as decanter stoppers, the effect produced by these imitation stones is excellent, but upon close inspection they appear coarse and clumsy, and do not resemble the genuine article in any way whatever.

Paste or "Strass."

There is, however, a kind of flint glass especially made to resemble precious stones, which is much more suitable for the purpose than the material used in theatrical jewels. This is known as "paste" or "strass," and possesses a great amount of brilliancy owing to the presence in the composition of the material of a large amount of oxide of lead.

The various colours of the different kind of gem stones are introduced into this material by means of the addition of oxides of manganese, cobalt, copper, iron, chromium and nickel.

The best imitation jewellery consists of this kind of paste which is cut and polished to more or less resemble the real precious stones upon somewhat similar tools to those used by the lapidary.

A great failing in pastes of this description is that the brilliancy which they possess when first manufactured does not last, but slowly deteriorates, owing to the action of the atmosphere upon the lead in their composition.

There is another variety of paste for which it is claimed that the composition is approximately identical with the material of the gem stones imitated. This is of French origin, but it is not largely used, for it differs little in appearance from the ordinary strass in general use, and its manufacture is restricted to certain colours.

How to detect pastes.

All varieties of paste can be detected from the precious stones they are intended to represent by

the presence within the material of bubbles and striæ, which are wholly unlike the marks to be seen in the real stones. Sometimes a feather or flaw is deftly introduced into a paste to increase its appearance of being genuine, but upon close inspection it is found to be of a different nature from the imperfections found in real stones.

Apart altogether from the general appearance and the internal markings, pastes never possess the correct hardness, specific gravity, and optical properties of the stones represented, and therefore by the application of a few simple tests, especially for hardness, they can be readily identified. Roughly speaking, it is sufficient to gently apply a small file to the edge of a paste to be quite sure of its nature, for its low degree of hardness is at once detected.

Doublets.

A very old form of imitation gem, largely sold in inexpensive and sham jewellery, is that which is known as the *doublet*. This consists of a thin piece of some gem stone, such as sapphire, of poor or worthless quality, cut to form the front of the so-called stone, while the back consists of paste of the desired colour of the gem to be imitated. The glass back is cemented on to the stone front with invisible cement, and the join between the two substances is hidden by the metal setting. The result is an apparently valuable gem which will resist the application of the test of hardness upon the front. If the doublet be viewed sideways the deception can be detected at once; it also will fall to pieces if soaked in spirit or even hot water.

Within recent years, however, doublets have been produced, the two pieces of which are welded to-

gether, and these cannot be divided by immersion in spirit, but present the same appearance when viewed through the girdle.

Triplets. A very similar production, known as the *triplet*, which consists of two pieces of crystal or worthless gem stone forming the front and the back, with a very thin piece of coloured glass, or perhaps only some coloured pigment in between.

The object of this, is that the test of hardness can be applied both to the front of the stone and to the culet without detection.

There are, however, few triplets upon the market, for with a little care they can easily be identified, especially if they be removed from the mount.

When gems are set with "a close back," that is, with the back of the stones unexposed from the metal, they are sometimes painted or foiled to enhance their appearance. This is done both with pastes and with stones of indifferent quality. The deception can generally be seen by careful examination of the article of jewellery, but the removal of the stones is desirable in order to ascertain their exact nature.

In very old-fashioned jewellery it was the custom to always set gems with a backing of gold, and not only were imitation and faulty gems painted at the back, but also precious stones of really fine quality were treated in the same way.

Artificial production of gems.—Distinct altogether from the spurious gem stones already described, are the wonderful modern productions of the laboratory, which can only be referred to as artificially manufactured precious stones.

Sir William Crookes, F.R.S., has demonstrated

that diamonds identical in every respect to the mined gems can be produced scientifically by the aid of an electric furnace, and it is true that several other gems can also be produced by means of modern science.

With one exception, these experiments have only resulted in the formation of stones of minute size, the small value of which is out of all proportion to the tremendous cost of production.

Artificially made rubies.

In the making of rubies artificially, the science of the day has been very successful, for it is now possible to procure these stones of marketable size. Except that they contain certain interior markings peculiar to themselves, and that their colour is somewhat unnatural in appearance, they are identical with rubies obtained from the mines.

The details of the method of manufacture are kept secret by the makers, but the following particulars will give the reader an impression of the process.

A small crystal of silicate of alumina, coloured by bi-chromate of potash, is rotated at a very high speed while kept at a temperature of about 1,800° Centigrade, by means of the oxy-hydrogen blowpipe. It is then "nursed" with minute particles of natural ruby, which adhere to, and become melted on to the centre core. With great care and patience a large bead can thus be built up, from which the rubies can afterwards be cut. The ruby material is, however, very apt to break directly it is allowed to cool, and also during the process of cutting.

There are several sources from which these manufactured rubies emanate and find their way upon the market, and they are sold under several different

names, such as "scientific rubies," "manufactured rubies," "reconstructed rubies," "made rubies." There is probably some slight difference in the method of manufacture of the various products, which, however, all have much about the same appearance.

These artificially made rubies are not recognized as gems by responsible vendors of precious stones, although large quantities are undoubtedly marketed.

It is useless to deny that some considerable experience and expert judgment is often necessary to accurately diagnose some of the artificially produced rubies. They possess the correct physical and optical properties of true rubies, therefore the tests for hardness, specific gravity, and refraction are of no assistance. It therefore rests entirely with the trained eye of the expert to detect the peculiarity of colour and the characteristic internal markings which they contain, details of which can only be appreciated by one who is accustomed to handle and examine large quantities of natural rubies.

Unnatural colour.

The quality of the manufactured rubies upon the market varies very considerably. Most of them are of such an unnatural colour, and are so full of the markings referred to, that they can be identified quite easily upon moderately close inspection. Others possess colour approaching that of real rubies, and exhibit the characteristic markings so slightly, that the greatest scrutiny, often with the aid of a strong lens or microscope, is necessary for diagnosis.

The markings which indicate the origin of the manufactured rubies consist of minute bubbles forming circular parallel lines of semi-opacity, and a

glassy effect consisting of a wavy circular appearance within.

The substance, in fact, looks somewhat as if it had once been in a semi-gelatinous condition, and, whilst being rapidly stirred round and round, had been allowed to dry suddenly.

The colour of the artificial product errs in being too much like brick dust, and there is also very little diversity of tone and depth of colour. From a large parcel of real rubies of moderate size it is a matter of some considerable difficulty to select a few which present exactly the same shade of colour, but this would not occur with a number of scientifically made rubies, for they would probably be all alike in this respect, or nearly so.

Artificial alteration of gem stones.—There are several gem stones which can be altered in colour by the careful application of heat. The most noteworthy of these is the brown or dark yellow Brazilian topaz, which can be changed to a charming rose-pink of varying shades, according to the density of the original colour.

The technical expression to describe the process is "burning" or "pinking." It is considered quite **Pinking.** legitimate to treat the topaz in this way, as the occurrence of the gem presenting a pink colour naturally is of extreme rarity, and consequently all the pink topazes upon the market have been thus altered.

A fine pink topaz forms a gem of very great beauty and some considerable value, and is greatly appreciated at the present day.

Another gem which can be altered in appearance by heat is the zircon. Some of the brown varieties

lose their colour by the treatment, either partially or entirely, the result being white, or almost white stones, which, owing to the high refractive power of zircon, bear a close resemblance to diamonds of indifferent quality, especially if they be cut with this object in view.

The brown quartz or cairngorm, when very dense in colour, can be affected by heat in the same way, the colour becoming less intense, and consequently more pleasing. The purple colour of the amethyst can be changed to mahogany brown by the same means.

The burning of precious stones is a very risky and difficult process, for the heat must be regulated to a very great nicety in order to ensure success; if too much heat be applied to the stones, either they will be found to be quite colourless or very much flawed, and if insufficient heat be given, the colour of the stones will be found to be unsatisfactory.

Also there is great danger of damaging the gems by too rapid a change of temperature; they should be warmed and cooled gradually.

The usual method of burning a gem-stone is to place it in a bed of silver sand over a gas stove, by which means it can be gradually warmed up to the required heat and cooled down again without any sudden change of temperature. The stone should not be removed from the sand until it is quite cold.

Another method is to wrap the stone in German tinder or amadou, bound round with thin wire. The amadou should then be burnt, and the stone afterwards removed.

By the modern chemist.

The colour of many varieties of chalcedony, which often present a gray or sandy appearance in their

natural state, can be altered or removed artificially by the modern chemist.

Advantage is taken of the nature of the material, which is more or less porous in different degrees, according to the rapid or slow deposition and crystallization during its formation. It is therefore sometimes possible to give colour to chalcedony by merely soaking it in dye or stain. It is also done by soaking the stone in several different chemical solutions successively, in which case chemical action takes place within the pores of the stone, and the required colours are thus produced.

By these means very many brilliant colours can be introduced into chalcedony, and give rise to the gaily coloured agates and carnelians, which all consist of the same material.

When the colour appears in parallel stripes or concentric rings, or otherwise unevenly distributed, the effect is caused by the material varying in porosity accordingly. Those parts which remain white, or nearly so, being those which have been formed most slowly.

The material can also be bleached artificially by heating and chemical treatment.

The industry of staining agates, carnelians, onyxes, and other varieties of chalcedony, is almost exclusively carried on in the neighbourhood of Oberstein, and Idar in Germany. In this locality, **Idar.** where the cutting of these stones forms the principal craft of the inhabitants, and where a great amount of cheap gem-cutting of every description is carried on, the art of bleaching and staining agates, etc., has reached a wonderful state of perfection. Not only are all imaginable colours produced in the

chalcedony, often all in the same piece of stone, but they are made to closely resemble different gem-stones of much greater value. For instance, agate is stained green to imitate chrysoprase, blue to counterfeit lapis-lazuli, etc.

Radium. It has been recently rumoured that an alteration in the colour of certain precious stones has been effected by means of radium, but the report needs confirmation.

TABLE OF CHARACTERISTICS AND LOCALITIES

CHARACTERISTICS AND LOCALITIES OF

Name of Gem.	Chemical Composition.	System of Crystal-lography.	Cleavage.	Fracture.	H.
Diamond.	Carbon 100	Cubic.	Parallel to faces of Octahedron, highly perfect.	Conchoidal.	10
Ruby.	Alumina .. .. 98.5 Oxide or Iron .. 1.0 Lime 5	Hexagonal.	Basal and Rhombohedral.	Conchoidal or uneven.	8.5 to 9
Sapphire.	"	"	"	"	9
Oriental Emerald (Green Sapphire).	"	"	"	"	"
Oriental Topaz (Yellow Sapphire).	"	"	"	"	"
Oriental Amethyst (Purple Sapphire).	"	"	"	"	"
Asteria or **Star Stone.**	"	"	"	"	"
Fancy Sapphire.	"	"	"	"	"
Spinel.	Alumina .. .. 71.99 Magnesia 28.01	Cubic.	Parallel to faces of Octahedron, highly perfect.	Sub-conchoidal.	8
Topaz.	Silica .. .. .. 33.3 Alumina .. .. 51.7 Fluorine 15	Rhombic.	Parallel to Basal Plane, and highly perfect.	" to uneven.	"
Tourmaline.	Silica combined with Oxides of Iron, Magnesium, Manganese, and Aluminium, and Boron in different proportions. Very variable.	Hexagonal.	Rhombohedral difficult.	Sub-conchoidal or uneven.	7 to 7.5

H. = Hardness. **S.G.** = Specific Gravity.

THE PRINCIPAL PRECIOUS STONES.

S.G.	Colour.	Diaphaneity.	Index of Refraction.	Refraction.	Pleochroism.	Principal Localities.	Mode of Occurrence.
3.52	Colourless, Yellow, Red, Blue, Brown, Pink, Green, and Black.	Transparent.	2.439	Single.	M.	India, Brazil, S. Africa, Australia.	In Quartzose Conglomerate.
3.9 to 4.2	All shades of Red.	"	1.794	Double in slight degree.	D.	Burma, Siam, Ceylon.	Frequently in Gravels of Rivers and Torrents.
"	All shades of Blue.	"	"	"	"	", Kashmir, Montana, Australia.	"
"	Green.	"	"	"	"	Ceylon, Queensland.	"
"	Yellow.	"	"	"	"	"	"
"	Purple.	"	"	"	"	Ceylon.	"
"	Red, Blue, and Gray.	"	"	"	"	Burma, Ceylon.	"
"	Pale shades of all Colours.	"	"	"	"	Ceylon, Montana, Australia.	"
3.5 to 3.6	Red, Blue, Green, Pink, Orange, Brown, also Black.	Transparent to Opaque.	1.755 to 1.809	Single.	M.	Ceylon, Siam, Burma.	Occurs in Granular Limestone, Gneiss, and Volcanic Rocks.
3.4 to 3.6	Colourless, Yellow, Brown, Blue, Pink.	Transparent to Sub-translucent.	1.635	Double in slight degree.	D.	Brazil, Pegu, Siberia, Saxony.	Frequently embedded in Quartz.
2.9 to 3.3	Red, Blue, Green, Brown, Yellow, and Black.	Transparent to Opaque.	1.625	Double.	"	California, Siberia, Ceylon, Ava, Brazil.	In Granite, Gneiss, Mica-slate, Chlorite-slate, and Granular Limestone.

M. = Monochroic. **D.** = Dichroic. **T.** = Trichroic.

Name of Gem.	Chemical Composition.	System of Crystallography.	Cleavage.	Fracture.	H.
Garnet.	Silica .. .. .. 35.5 Alumina .. .. 21 Oxide of Iron .. 35.5 Oxide of Manganese .. .. .. 1.5 Magnesia .. .. 4 Lime .. .. .. 2.5 Very variable.	Cubic.	Parallel to the faces of the Dodecahedron.	Sub-conchoidal or uneven.	6.5 to 7.5
Peridot or Olivine.	Silica .. .. .. 39.3 Alumina .. .. .2 Magnesia .. .. 49.3 Protoxide of Iron 11.2	Rhombic.	Prismatic.	Imperfectly conchoidal.	6—7
Chrysolite.	"	"	"	"	"
Emerald.	Silica .. .. .. 68 Alumina .. .. 18.3 Glucina .. .. 12.2 Magnesia .. .. .8 Soda 7	Hexagonal.	Parallel to Basal Plane indistinct.	Conchoidal or uneven.	7.5 to 8
Beryl or Aquamarine.	"	"	"	"	"
Phenakite.	Silica .. .. .. 55.52 Glucina 44.48	"	Parallel to faces of Rhombohedron, indistinct.	Conchoidal.	7.5
Euclase.	Silica .. .. .. 43.2 Alumina .. . 33.6 Glucina 23.2	Monoclinic.	Parallel to faces of the Prism.	"	"
Zircon or Jargoon.	Silica .. .. .. 33.77 Zirconia 66.23	Tetragonal.	Parallel to faces of Prism, indistinct; to Pyramid, still less distinct.	"	"
Jacinth.	"	"	"	"	"
Chrysoberyl.	Alumina .. .. 80.2 Glucina 19.8	Rhombic.	Distinct Parallel to Brachydome; less distinct Parallel to Brachypinakoid.	"	8.5
Alexandrite.	"	"	"	"	"
Cat's-eye.	"	"	"	"	"
Spodumene.	Silica .. .. .. 66.14 Alumina .. .. 27.02 Peroxide of Iron .. 0.32 Lithia .. .. .. 3.84 Soda 2.68	Monoclinic.	Very perfect Parallel to the Orthopinakoid.	Uneven.	6.5 to 7
Hiddenite.	"	"	"	"	"
Kunzite.	"	"	"	"	"

S.G.	Colour.	Diaphaneity.	Index of Refraction.	Refraction.	Pleochroism.	Principal Localities.	Mode of Occurrence.
3.15 to 4.3	Many shades of Red and Brown, also Green.	Transparent to Opaque.	1.815	Single.	M.	Brazil, India, Ceylon, Australia, S. Africa.	In Alluvial Deposits, and in Gneiss, Mica-schist, etc.
3.3 to 3.5	Chartreuse Green.	,,	1.660	Double.	D.	Levant, Egypt.	Frequently in boulders of Basalt.
,,	Primrose Yellow.	,,	,,	,,	,,	,,	,,
2.63 to 2.75	"Emerald" Green.	,,	1.585	Double in very slight degree.	,,	India, S. America, Siberia.	In Limestone.
,,	Colourless, Blue, Green, Yellow.	,,	,,	,,	,,	,,	,,
2.966 to 2.99	Colourless and Pale Yellow.	,,	1.62	Double.	,,	Peru.	In Mica-schist.
3.03 to 3.09	Bluish Green.	,,	,,	,,	T.	Peru, Brazil, The Urals.	Frequently in Chlorite-slate.
4.7	Brown, Yellow, Green.	,,	1.961	Double in very slight degree.	D.	Ceylon, Queensland.	In Syenite and Crystalline, Limestone, Gneiss, Chlorite-schists, etc., also in Alluvial Deposits.
,,	Cinnamon Colour.	,,	,,	,,	,,	,,	,,
3.5 to 3.8	Yellow, Brown, Sage Green.	,,	1.760	Double.	,,	Ceylon, Brazil, The Urals.	In association with Zircons, Sapphires, etc.
,,	,,	,,	,,	,,	,,	,,	,,
,,	,,	,,	,,	,,	,,	,,	,,
3.2	Primrose Yellow, Greenish Yellow.	,,	1.67	,,	,,	Brazil, Tyrol, Massachusetts.	With Magnetic Iron Ore, Quartz, and Tourmaline.
3	Grass Green.	,,	,,	,,	,,	N. Carolina.	,,
,,	Peach.	,,	,,	,,	,,	California.	,,

Name of Gem.	Chemical Composition.	System of Crystallography.	Cleavage.	Fracture.	H.
Amethyst.	Silica 100	Hexagonal.	None, or only very indistinct traces occasionally procured with much difficulty.	Conchoidal.	7
Cairngorm.	,,	,,	,,	,,	,,
Iolite.	Silica .. .. .. 48.42 Alumina .. .. 31.72 Magnesia .. .. 10.76 Protoxide of Iron 8.32 Protoxide of Manganese .. .. .3 Water .. .. .. .48	Rhombic.	Brachy-diagonal.	Uneven to conchoidal.	7 to 7.5
Moonstone.	Silica .. .. .. 65.69 Alumina .. .. 17.97 Potash .. .. .. 13.99 Lime .. .. .. 1.34 Soda 1.01	Monoclinic.	Massive, or in extremely complicated forms.	Conchoidal to uneven and splintery.	6
Epidote.	Silica .. .. .. 37.6 Alumina .. .. 25 Peroxide of Iron .. 13.5 Lime .. .. .. 20.5 Protoxide of Manganese .. .. .6 Water .. .. .. 1.8 Variable.	,,	Perfect Orthodiagonal.	Uneven.	6—7
Axinite.	Silicate of Lime, Alumina, Sesqui-oxides of Iron, Manganese, with a little Boracic Acid and Magnesia.	Triclinic.	Distinct parallel to Brachypinakoid.	Small and imperfect.	6.5 to 7
Sphene or Titanite.	Silica .. .. .. 30 Titanic Acid .. 42 Lime 28	Monoclinic.	Easy Parallel to the faces of the Prism.	Imperfect conchoidal.	5 to 5.5
Diopside.	Silica .. .. .. 52.2 Lime .. .. .. 24.5 Magnesia .. .. 16.5 Protoxide of Iron 5.3 Protoxide of Manganese 1.5	,,	Parallel with Planes of Oblique Rhombic Prism.	Uneven.	5—6
Turquoise.	Alumina .. .. 44.6 Phosphoric Acid .. 30.8 Oxide of Copper .. 3.7 Protoxide of Iron 1.9 Water 19	Amorphus.	—	Small conchoidal.	6
Precious Opal.	Hydrous Silica.	,,	—	Conchoidal.	5.5 to 6.5

S.G.	Colour.	Diaphaneity.	Index of Refraction.	Refraction.	Pleochroism.	Principal Localities.	Mode of Occurrence.
2.5 to 2.8	Purple.	Transparent to Opaque.	1.549	Double.	D.	India, Spain, Siberia.	Found in all Igneous Rocks.
,,	Brown, Yellow.	,,	,,	,,	,,	Common in all Countries.	,,
2.6 to 2.7	Smoky Bluish Gray.	,,	1.57	,,	,,	Spain, Bavaria, Ceylon.	Embedded in Granite, also in Quartz.
2.39 to 2.62	Colourless and Bluish White.	,,	1.55	Double slight.	,,	Ceylon.	In Granite Rocks.
3.2 to 3.5	Green, Yellow Gray, Red, and Black.	,,	1.7	Double.	,,	Urals, Greenland, Norway.	In Igneous Rocks and in various Crystalline Slates.
3.27	Purplish Blue, Brown, and Gray.	Transparent to Translucent.	1.68	,,	T.	Norway.	Occurs in Igneous Rocks.
3.4 to 3.56	Golden Yellow to Brown.	,,	1.88	,,	D.	St. Gothard, Norway, United States.	In Granite, Gneiss, Mica-schist, also in Volcanic Rocks.
3.2 to 3.5	Greenish White to Grayish Green.	,,	1.66	,,	,,	Piedmont.	Occurs in Basalt and other Volcanic Rocks.
2.6 to 2.8	Sky Blue.	Opaque to Semi-opaque.	—	—	—	Persia, Egypt, New Mexico.	Probably resulted from the alteration of Apatite.
2.21	Almost Colourless (Iridescent).	Transparent.	1.05	Single.	—	Queensland, New S. Wales, Hungary, Mexico.	In Ferruginous Sandstone.

APPENDIX

HOW TO PREPARE SONSTADT'S SOLUTION AND THE DOUBLE THALLIUM-SILVER NITRATE FOR THE PURPOSE OF TAKING SPECIFIC GRAVITY

Sonstadt's solution.

SONSTADT'S solution may be prepared by adding potassium iodide to distilled water, which may with advantage be warmed, until no more appears to dissolve after standing a day or two, and then adding to this mercuric iodide until, in like manner, no more enters into the solution. Both chemicals should be finely powdered, and shaking at frequent intervals is necessary. Towards the close of the operation it is better to add a mixture of potassium iodide and mercuric iodide in roughly equal proportions. After a lapse of some days the liquid may be filtered and roughly tested by putting into it a stone having a specific gravity of 3.0; if this should float the solution is probably of sufficient density, and it only remains to determine with some approach to accuracy what that density is. This can only be done properly by one who has had the necessary scientific training and has the resources of a laboratory at his disposal. Failing these, the best method is to purchase, as can now be done from most makers of chemical apparatus, one or more glass bulbs of the specific gravity required. If a bulb of S. Gr. 3.17 be obtained, the solution can

be adjusted by the addition of water or the mixed salts, until the bulb remains for a few seconds, without either rising or falling, in any position in which it may be placed in the liquid. Having accomplished this, three of the portions must be brought to the three densities lower than 3.17 already mentioned (Chapter I, page 9). This can be effected by reducing the density of each by the addition of distilled water, and the quantity of water to be added in each case can be determined by the following formula: Let $g =$ the S. Gr. of the liquid to start with, and let $g^1 =$ the S. Gr. after reduction; also let $x =$ the number of volumes of the liquid to be added to one volume of water, then $x = \frac{g^1 - 1}{g - g^1}$

Having measured and added the required quantity of water, it is advisable to test the specific gravity once or twice, and add more water if required, as more than one adjustment is usually necessary in order to obtain anything like an accurate result.

The accuracy of these solutions is in turn ascertained by means of the bulbs already mentioned. Gems of accurately determined gravity, if these can be obtained, will obviously do as well.

A certain degree of accuracy is, of course, necessary for the solutions to be of any practical utility, but as the specific gravity of similar gems is not invariable, an error within .005 is negligible.

It is a convenience to keep a bulb or a gem of suitable density in each of the liquids, so that it can be seen at a glance when any serious change in concentration has taken place, as the density alters, though very slowly.

If the solutions be kept in very wide-mouthed stoppered bottles, they are always ready for use. When the gem to be tested has been dropped into the solution, it must always be extracted by means of steel or ebonite forceps. The gem and forceps should be carefully rinsed in distilled water and dried after each experiment, as otherwise, the next solution in which they are placed is affected by the amount of moisture left on them. It is advisable to keep a bottle of distilled water specially for these rinsings, which may be filtered and evaporated and used to replenish the solutions from time to time.

Double thallium-silver nitrate.

The double thallium-silver nitrate is made from the nitrates of these metals, but can now be purchased in the solid form from Messrs. Kahlbaum of Berlin, or their agents in other places. To make two solutions of about 60 c.c. take about 265 grammes of the salt and dissolve in about 200 c.c. in distilled water. Then concentrate by evaporation, taking the precaution to exclude light and dust as much as possible until a stone of S. Gr. 3.5 just floats. Divide the liquid into two parts and continue the concentration of one portion until a stone of S. Gr. .4 just floats. The temperature of 70° to 100° is required for this operation, and as the liquid evaporates much more rapidly than Sonstadt's solution, it is even more necessary to keep in it a stone of definite specific gravity as an index.

I find the most convenient method of keeping the double nitrate is in wide short-necked flasks with a watch glass laid over the top. When not in use the whole can be protected in a wide-mouthed stoppered bottle, and kept steady by means of cotton wool.

While cooling, crystals form in the solution, and these must be entirely dissolved before it can be used. To do this a temperature of a least 70° is required, and a small hot air or water oven is convenient for the purpose. This should be provided with a shelf to stand the flasks upon, two glass windows so that they can easily be seen, and removable covers or trap doors in the top, so arranged that the flasks with their watch glasses can be put through them on to the shelf. As the crystals dissolve, careful rotary motion will render the liquid homogeneous, and it is then ready for use. After the introduction of a stone into the liquid the watch glass should be immediately replaced, and it is advisable to warm the stone before the test is applied.

The gems can be manipulated by means of steel forceps, and these with the gems should be rinsed in *warm* water and wiped after each operation, the water being carefully preserved for replenishing the solutions, when they require their specific gravity readjusting owing to loss of water by evaporation. On no account should any of the liquid be allowed to touch the hands, as it leaves a stain which cannot be washed off.

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